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The Insect-Galls of the Vicinity of New York City

BY

William Beutenmüller

Curator of Entomology

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Guide Leaflet No. 16

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The Insect-Galls

of the

Vicinity of New York City.

A Guide Leaflet to the Collection

in the

American Museum of Natural History,

New York.

By

WILLIAM BEUTENMÜLLER,

CURATOR OF ENTOMOLOGY.

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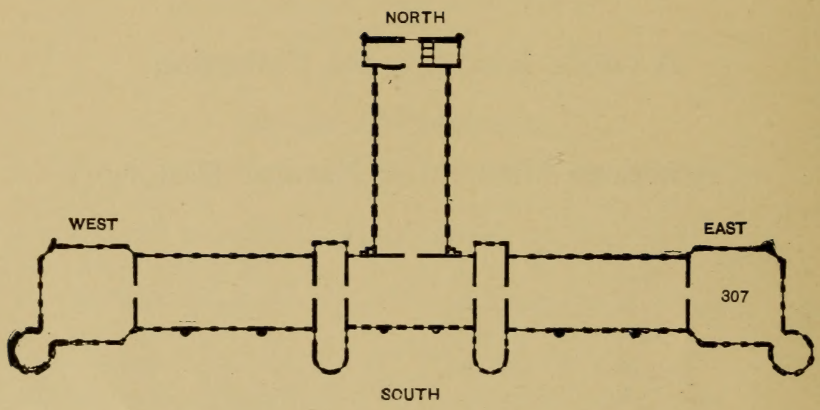


THIRD, OR GALLERY, FLOOR.

The collection of Insect-Galls upon which this Guide Leaflet is based is exhibited in Hall No. 307 of the East Wing, third floor of the Museum.

THE INSECT-GALLS OF THE VICINITY OF NEW YORK CITY.

EVERYWHERE throughout the woods, along the roadsides and in the fields, one finds on leaf or twig, stem or root peculiar swellings which evidently are not part of the normal growth of the plant. These deformations when produced by insects are called Galls. Generally one or more eggs are inserted in a bud, a flower, a leaf, a root or some other part of the plant, and the presence of this foreign body, together with the irritation caused by the larva among the vegetable cells, produces an abnormal growth of definite shape and uniform structure. The variety of Galls in respect to structure and substance is great. Every species of Gall-producing insect attacks its own particular plant and a particular part of that plant. Galls are of various sizes and colors and of almost every conceivable shape. Some resemble a tomato or a potato. Some are like the apple, plum, cherry and other small fruits. Some have the appearance of a pine-cone or a seed. They are smooth, wrinkled, downy, hairy or covered with spines and other protuberances. Some are succulent, while others are so fragile that they can be readily crushed, and still others are so corky, hard and woody that it requires a sharp knife to cut them. In color they are of many shades of green, yellow, red, brown and white.

The number of Galls formed by distinct species of insects and mites is so large that only a small proportion of the excrescences or of the insects causing them has yet been described. The present Guide Leaflet gives brief accounts, illustrated by figures drawn to a uniform scale, of some of the more conspicuous Galls made by members of the following families of insects found in the vicinity of New York City:

(1.) **Hymenoptera** (CYNIPIDÆ and TENTHREDINIDÆ)—Gall-flies and Saw-flies.

(2.) **Diptera** (CECIDOMYIIDÆ, MYCETOPHILIDÆ and TRYPETIDÆ)—Flies.

(3.) **Hemiptera** (PSYLLIDÆ and APHIDIDÆ)—Plant-lice and Jumping-lice.

(4.) **Acarina** (ACARIDÆ)—Mites.

Besides these groups, which are the principal Gall-producers, some few species of other orders (Coleoptera and Lepidoptera) also produce Gall-like excrescences.

In the following list, the Galls which have been found in the vicinity of New York City are arranged according to the plants upon which they occur. The serial numbers refer to the descriptions on the succeeding pages.

Species No.

Wild Rose (*Rosa* sp.).

Rhodites bicolor..... 1.
" *radicum*..... 2.
" *globulus*..... 3.
" *dichlocerus*..... 4.
" *verna*..... 5.
" *rosæ*..... 6.
" *ignota*..... 7.
" *lenticularis*..... 8.

Trailing Blackberry (*Rubus canadensis*).

Diastrophus bassettii..... 9.

Blackberry (*Rubus villosus*).

Diastrophus cuscutæformis.. 10.
" *nebulosus*..... 11.

Black Raspberry (*Rubus occidentalis*).

Diastrophus radicum..... 12.

Cinquefoil (*Potentilla canadensis*).

Diastrophus potentillæ..... 13.

Scarlet Oak (*Quercus coccinea*).

Amphibolips confluentus..... 14.
" *inanis*..... 15.
Andricus punctatus..... 20.
Cecidomyia pilulæ..... 66.

Red Oak (*Quercus rubra*).

Amphibolips confluentus.... 14.
" *inanis*..... 15.
" *cælebs*..... 17.
" *prunus*..... 18.
Andricus singularis..... 27.
Cecidomyia pilulæ..... 66.
" *niveipila*..... 68.

Species No.

Black Oak (*Quercus velutina*).

Amphibolips confluentus..... 14.
Andricus piger..... 31.
Cecidomyia pilulæ..... 66.

Scrub Oak (*Quercus nana*).

Amphibolips ilicifoliæ..... 16.
Andricus punctatus..... 20.
" *similis*..... 24.
Cecidomyia pilulæ..... 66.

Rock Chestnut Oak (*Quercus prinus*).

Andricus papillatus..... 23.
" *petiolicola*..... 28.

White Oak (*Quercus alba*).

Andricus seminator..... 21.
" *futilis*..... 22.
" *clavula*..... 25.
" *petiolicola*..... 28.
" *lana*..... 29.
Cynips pisum..... 34.
Acraspis erinacei..... 35.
Biorhiza forticornis..... 36.
Holcaspis globulus..... 37.
Neuroterus batatus..... 41.
Cecidomyia poculum..... 67.

Pin or Swamp Oak (*Quercus palustris*).

Andricus cornigerus..... 19.
" *palustris*..... 26.
Cecidomyia pilulæ..... 66.

Black Jack Oak (*Quercus marylandica*).

Andricus punctatus..... 20.
Cecidomyia pilulæ..... 66.

Species No.

Swamp White Oak (*Quercus platanoides*).

Andricus petiolicola..... 28.
" *capsulus*..... 30.
Cynips strobilana..... 33.
Holcaspis duricaria..... 38.
Neuroterus pallidus..... 40.
" *noxiosus*..... 42.
" *floccosus*..... 43.
" *umbilicatus*..... 44.

Post Oak (*Quercus minor*).

Andricus petiolicola..... 28.
Dryophanta polita..... 39.

Scrub Chestnut Oak (*Quercus prinoides*).

Cynips prinoides..... 32.

Wild Lettuce (*Lactuca canadensis*).

Aulax tumidus..... 46.

Willow (*Salix* sp.).

Nematus pomum..... 47.
Euura ovum..... 48.
Cecidomyia strobiloides..... 61.
" *rigidæ*..... 62.
" *batatas*..... 63.

Alder (*Alnus rugosa*).

Cecidomyia serrulatæ..... 49.

Basswood (*Tilia americana*).

Cecidomyia verrucicola..... 50.

Tulip-tree (*Liriodendron tulipifera*).

Cecidomyia tulipifera..... 51.
" *liriodendri*..... 52.

Wild Cherry (*Prunus serotina*).

Cecidomyia serotinæ..... 53.
Acarus serotinæ..... 87.

White Ash (*Fraxinus americana*).

Cecidomyia pellex..... 54.

Honey Locust (*Gleditschia triacanthos*).

Cecidomyia gleditschiæ..... 55.

Species No.

Hickory (*Hickoria* sp.).

Cecidomyia holotricha..... 56.
" *caryæcola*..... 57.
" *tubicola*..... 58.
" *sanguinolenta*..... 59.
" *persicoides*..... 60.
Phylloxera caryæcaulis..... 86.

Dogwood (*Cornus florida*).

Cecidomyia clavula..... 64.

Touch-me-not (*Impatiens biflora*).

Cecidomyia impatiens..... 65.

Goldenrod (*Solidago* sp.).

Cecidomyia solidaginis..... 69.
Trypeta polita..... 74.
" *solidaginis*..... 75.

Grape (*Vitis* sp.).

Cecidomyia viticola..... 70.
" *vitis-pomum*..... 71.
Lasioptera vitis..... 72.

Red Maple (*Acer rubrum*).

Sciara ocellata..... 73.

Hackberry (*Celtis occidentalis*).

Pachypsylla venusta..... 76.
" *celtidis-gemma*... 77.
" " *-vesiculum* 78.
" " *-mamma*.. 79.
" " *-cucurbitæ* 80.

Witch Hazel (*Hamamelis virginiana*).

Hormaphis hamamelidis..... 81.
" *spinosus*..... 82.

Elm (*Ulmus americana*).

Colopha ulmicola..... 83.

Sumac (*Rhus glabra*).

Pemphigus rhois..... 84.

Huckleberry (*Vaccinium* sp.).

Solenozopheria vaccinii..... 45.

Poplar (*Populus* sp.).

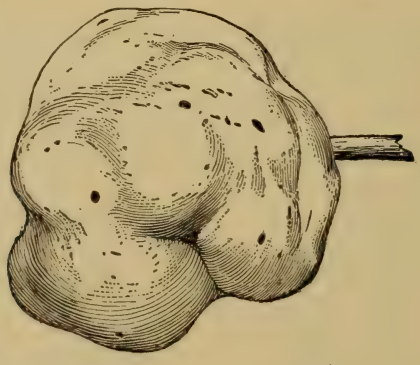
Pemphigus populicaulis..... 85.

HYMENOPTERA. (Bees, Wasps etc.)

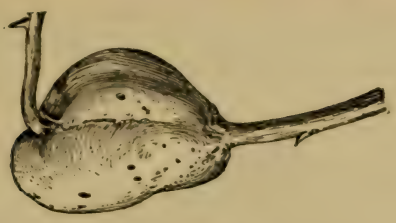
Family Cynipidæ (Gall-flies).

The species belonging to this family are small wasp-like insects termed Gall-flies because the majority of the species live within Galls. In the adult Gall-fly, the abdomen is usually much compressed and is joined to the thorax by a short peduncle. The wings have comparatively few veins, while some species are wingless. The antennæ are not elbowed. They consist of from 13 to 16 joints. The larvæ are maggot-like.

1. **Spiny Rose Gall** (*Rhodites bicolor* Harr.).—Spherical, covered with many long prickly spines. Yellowish green sometimes tinged with red in summer, and brown in winter. Soft in summer, woody in winter. Diameter ⅜ to ½ in. On twigs of wild roses. Rather common.



2. **Rose Root Gall** (*Rhodites radicum* Osten Sacken).—Irregularly rounded, with a deep impression above and below at place of attachment. Smooth, reddish brown. Pithy in substance, containing numerous cells. Length 1½ to 2 in. At roots of the wild roses. Not common.



3. **Globular Rose Gall** (*Rhodites globulus* Beuten.).—Smooth, rounded or oblong, rising at each end abruptly from the branch. Rather soft and corky, containing numerous cells. About ¾ to 1 in. long and ¾ in. in diameter. On swamp rose (*Rosa carolina*). Not common.

4. **Long Rose Gall** (*Rhodites dichlocerus* Harr.).—Elongated, hard and woody, gradually tapering at both ends. Color reddish. Length from 1½ to almost 2 in. Width about ½ in. On stems of wild roses. Not common.

5. **Knotty Rose Gall** (*Rhodites verna* Osten Sacken).—Oblong or rounded and ½ in. long. Sometimes there is a series of three or more swellings attached to each other. Reddish, hard and woody, with many cells inside. On stems of wild roses. Not common.

6. **Mossy Rose Gall** (*Rhodites rosæ* Linn.).—Composed of an agglomera-

tion of hard cells around a branch and is densely covered with long green filaments forming a moss-like mass. About 1½ in. in diameter. On the twigs of sweet brier (*Rosa rubiginosa*). Common locally.

7. **Mealy Rose Gall** (*Rhodites ignota* Osten Sacken).—Round, woody, about the size of a large pea, and covered with a white mealy substance. Sometimes two or three coalesce, thus forming an elongated mass of more irregular shape. Inside are several cells. On leaves of wild roses. Common.

8. **Rose Lentil Gall** (*Rhodites lenticularis* Bass.).—Lentil shaped. In the parenchyma of the leaves of the wild rose (*Rosa lucida*). $\frac{1}{10}$ to $\frac{1}{7}$ in. in horizontal, and $\frac{1}{5}$ in. in vertical diameter. Not common.

9. **Bassett's Blackberry Gall** (*Diastrophus bassettii* Beuten.).—Irregularly

rounded or somewhat elongated. From about ½ to 1 in. in diameter. Composed of a pithy substance with many rounded cells inside. Greenish, tinged with red. On the stems of the trailing blackberry (*Rubus canadensis*), close to the ground. Not common.

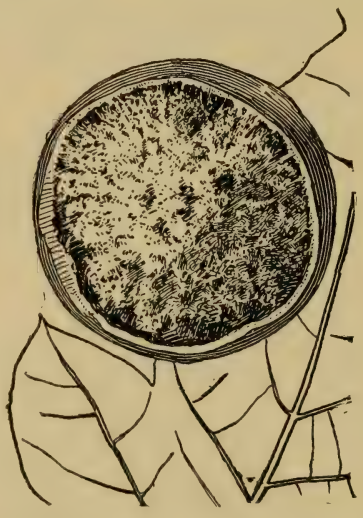
10. **Blackberry Seed Gall** (*Diastrophus cuscutæformis* Osten Sacken).—Consists of small globular, woody, seed-like bodies, pressed closely together, each provided more or less with spines. On stems of blackberry. Not common.

11. **Blackberry Knot Gall** (*Diastrophus nebulosus* Osten Sacken).—Oblong, surface somewhat uneven, with deep longitudinal furrows which divide the gall more or less completely into four or five parts. Length from 1 to 3 in. and diameter about 1 to 1½ in. Dark green, turning reddish as the season advances. Hard, corky, with many oblong cells inside. On stalks of blackberry (*Rubus villosus*). Very common.

12. **Raspberry Root Gall** (*Diastrophus radicum* Bass.).—Irregularly rounded. Varying greatly in size and in shape from that of a pea to bodies

nearly 2 in. in length and 1 in. in diameter. On roots of black raspberry (*Rubus occidentalis*). Common.

13. **Cinquefoil Axil Gall** (*Diastrophus potentillæ* Bass.).—Spherical or oblong, about $\frac{1}{3}$ to $\frac{1}{2}$ in. in diameter, containing a single cell. Green in summer; brown and spongy in winter. On axils of leaves of cinquefoil (*Potentilla canadensis*). Common.



14. **Oak or May Apple** (*Amphibolips confluentus* Harr.).—Large, globular, more or less smooth outside and filled with a spongy substance, in the center of which is a hard woody kernel containing the larval cell. From 1 to 2 in. in diameter. When fresh, it is pale green, soft and succulent, with the contents whitish. Later in the season the shell becomes brown, hard and brittle, with the kernel woody and the spongy substance dark brown, but remaining soft. Confined to the leaves of the trees belonging to the red oak group. Common.

15. **Empty Oak Apple** (*Amphibolips inanis* Osten Sacken).—Shape like the preceding, but considerably smaller. Almost empty, the larval cell being kept in position by radiating filaments. Green and soft when young; brown and brittle when dry. On leaves of scarlet (*Quercus coccinea*) and red oak (*Q. rubra*).

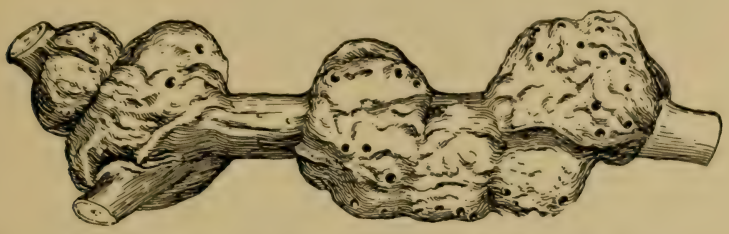
16. **Scrub Oak Gall** (*Amphibolips ilicifoliæ* Bass.).—Elongated, fusiform, tapering at both ends, with the apex long and more slender than the base. Length about 1½ in.; width about ¾ inch. Within is an elongated kernel held in position by radiating fibers. Green and soft in summer; brown and brittle in winter. On the leaves and petioles of dwarf oak (*Quercus nana*). Not common.

17. **Oak Spindle Gall** (*Amphibolips cœlebs* Osten Sacken).—Elongated, spindle-shape, soft and green. Contains a kernel held in position by radiating fibers. Length $1\frac{1}{5}$ in. On leaf of red oak (*Quercus rubra*). Not common.

18. **Acorn Plum Gall** (*Amphibolips prunus* Walsh).—Globular, somewhat wrinkled or smooth, fleshy but solid; resembles a plum or cherry. About $\frac{1}{2}$ to 1 in. in diameter. Bright crimson outside, pinkish inside and shading to yellow towards the center. In the center is a single cell in which the larva lives. On cup of acorn of red oak (*Quercus rubra*). August and September. Sometimes rather common.

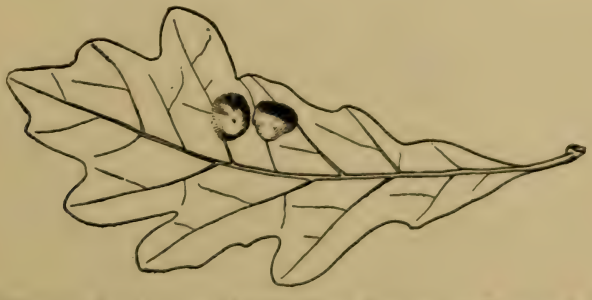
19. **Horned Knot Oak Gall** (*Andricus cornigerus* Osten Sacken).—Irregularly globular with many horn-like protuberances through which the gall-flies escape. Very hard and woody. Color of the branch. Inside brown with many larval

cells. About ½ to 1⅛ in. in diameter. On branches of the pin oak (*Quercus palustris*). Exceedingly common throughout the year.



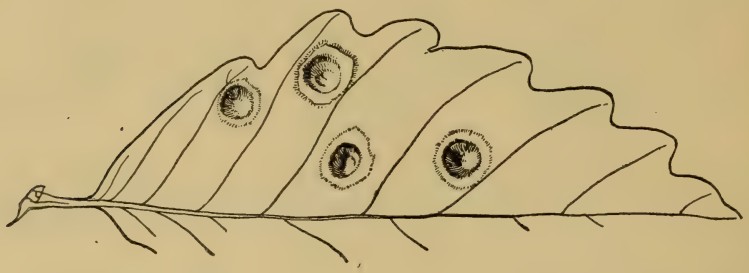
20. **Oak Knot Gall** (*Andricus punctatus* Bass.).—Shape similar to the preceding gall, but without the horn-like protuberances. Sometimes found singly, but often a number may be seen, in greater or less proximity, on the same branch. On black jack oak (*Quercus marylandica*), scarlet oak (*Quercus coccinea*) and rarely on scrub oak (*Quercus nana*). Common.

21. **Oak Seed Gall** (*Andricus seminator* Harr.).—Composed of a woolly substance and irregularly rounded. Inside are numerous bodies adhering to the twig and resembling canary seeds. About 1 to 1¾ in. in diameter. Pure white sometimes tinged with red; toward the middle of the summer it assumes a rusty brown color and gradually drops off the twig. On twigs of white oak (*Quercus alba*). Common.



22. **Oak Wart Gall** (*Andricus futilis* Osten Sacken).—Rounded, somewhat

flattened, projecting on both sides of the leaf. Inside are two or three seed-like, oblong kernels, kept in position by white filaments. Pale green. In numbers on leaves of white oak (*Quercus alba*). Very common.



23. **Oak Nipple Gall** (*Andricus papillatus* Osten Sacken).—Rounded and somewhat nipple-shaped. Projects on both sides of the leaf and is enclosed in a reddish areola on the under side of the leaf. This is a very characteristic feature and distinguishes it from the preceding species. Inside are two or three kernels each containing a single larva. In numbers on leaves of chestnut oak (*Quercus prinus*). Common.

24. **Scrub Oak Club Gall** (*Andricus similis* Bass.).—Club-shaped, blunt at apex, which is generally turned to one side. Length ½ to 1 in. Hard and woody, with a few leaves growing from it in summer. On terminal twigs of scrub oak (*Quercus nana*). Not common.

25. **White Oak Club Gall** (*Andricus clavula* Bass.).—Club-shaped, hard and woody, with a few leaves growing from it. Length ½ to 1 in. Green in summer; brown in winter. On tips of twigs of white oak (*Quercus alba*). Very common.

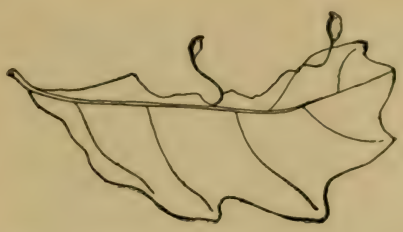
26. **Succulent Oak Gall** (*Andricus palustris* Osten Sacken).—Globular, green, succulent. Hollow inside, with a small seed-like kernel which rolls about freely. Diameter about ½ in. On buds and young leaves of pin oak (*Quercus palustris*). May.

27. **Small Oak Apple** (*Andricus singularis* Bass.).—Globular, smooth,

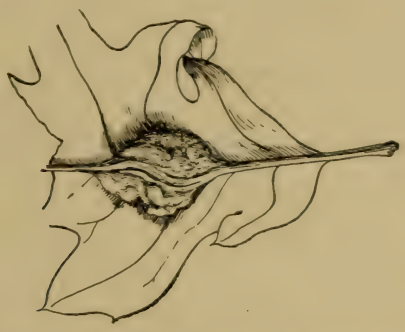
with an oblong kernel inside held in position by radiating fibers. Green and soft in spring; brown and brittle later in the season. Varies from $\frac{1}{4}$ to $\frac{1}{2}$ in. in diameter. On leaves of red oak (*Quercus rubra*). Rather common.

28. **Oak Petiole Gall** (*Andricus petiolicola* Bass.).—Rounded or club-shaped, hard and woody, with many cells inside. About $\frac{3}{4}$ in. in diameter. Green in summer; brown in winter. On petiole, base or midrib of leaf of white oak (*Quercus alba*), chestnut oak (*Quercus prinus*), swamp white oak (*Quercus platanoides*) and post oak (*Quercus minor*). Common.

29. **Oak Wool Gall** (*Andricus lana* Fitch).—Very much resembles a mass of wool about $\frac{5}{8}$ in. long. White or buff colored, inside with many small, bright chestnut colored, seed-like capsules, crowded together and attached by their lower ends to the vein of the leaf. On the under side of ribs of leaf of white oak (*Quercus alba*). Common.



30. **Oak Capsule Gall** (*Andricus capsulus* Bass.).—Oval and attached to a pedicel, ½ to ¾ in. long. Resembles the capsule of certain mosses. On the margin of leaf of swamp white oak (*Quercus platanoides*). Not common.



31. **Oak Midrib Gall** (*Andricus piger* Bass.).—A large, irregular woody swelling on the midrib of leaf of black oak (*Quercus velutina*), always on the under side and usually on the lower half of the leaf. Upper side indicated by a widening of the midrib and a slight depression of the leaf at that point. Rather common.

32. **Spiny Oak Gall** (*Cynips prinoides* Beuten.).—Globular, covered with numerous cone-like projections, hard and woody, with a small cell inside. About ½ in. in diameter. Green, tinged with red. On upper side of leaf of dwarf chestnut oak (*Quercus prinoides*). Not common.

33. **Pine-Cone Oak Gall** (*Cynips strobilana* Osten Sacken).—Consists of many wedge-shaped bodies, closely packed together, with their pointed bases attached to a common center. Hard and corky with a single cell in each. They break off readily when dry. On twigs of swamp white oak (*Quercus platanoides*). Not common.

34. **Oak Pea Gall** (*Cynips pisum* Fitch).—Globular, green and about the size of a pea, which it resembles in general appearance. Surface finely netted with fissures or cracks and intervening elevated points. Inside are two cavities divided in the middle by a thin partition. On upper and under sides of leaves of white oak (*Quercus alba*).

35. **Oak Hedgehog Gall** (*Acraspis erinacei* Walsh).—Rounded or oblong

oval, covered with numerous, rather long spines. Length about ¾ in. Yellow or greenish yellow with the spines bright red, especially when young. On one of the principal veins of leaf of white oak (*Quercus alba*). Common.

36. **Oak Fig Gall** (*Biorhiza forticornis* Walsh).—Consists of many small, soft, bladder-like bodies, each containing a single cell, which is held in position by radiating fibers. They are closely pressed together and somewhat resemble figs packed in boxes,—hence the name " Fig Gall." Pale yellow, often beautifully tinged with bright red. Brown in winter. On twigs of white oak (*Quercus alba*). Common.

37. **Oak Bullet Gall** (*Holcaspis globulus* Fitch).—Bullet-like, corky, with a small cavity in the center containing a single larva living in an oval, whitish

shell. Yellow, tinged with red in summer; brown in winter. Grows singly or in clusters of two or three on terminal twigs of white oak (*Quercus alba*). Common.

38. **Pointed Bullet Gall** (*Holcaspis duricaria* Bass.).—Globular, with a short point at the apex. Hard and woody, with a small cavity in the center containing a small oval, whitish shell in which the larva lives. Yellow and tinged with red in summer; brown in winter. On terminal twigs of swamp white oak (*Quercus platanoides*) growing singly or in clusters of two or more. Common.

39. **Polished Oak Gall** (*Dryophanta polita* Bass.).—Globular, smooth, with a thin outer shell Inside is a single round cell held in position by radiating fibers. Pale green, sometimes tinged with red, and about $\frac{1}{4}$ to $\frac{3}{4}$ in. in diameter. On both surfaces of the leaves, at or near the summit of young and thrifty shoots, of post oak (*Quercus minor*). Grows singly or in clusters. August and September. Not rare in the pine barrens of New Jersey.

40. **Oak Flower-Stem Gall** (*Neuroterus pallidus* Bass.).—Small, unevenly globular, smooth and of a fine, soft cellular consistence. Pale wood color. In masses on flower stems of swamp white oak (*Quercus platanoides*). Not common.

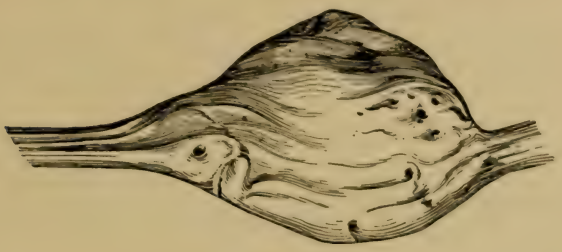
41. **Oak Potato Gall** (*Neuroterus batatus* Fitch).—Generally large and uneven, often resembling a potato in shape. Hard and woody, the surface being coated with a pale bluish bloom. Inside it is dense, corky, with many larval cells. On white oak (*Quercus alba*) below the terminal shoot. Common.

42. **Noxious Oak Gall** (*Neuroterus noxiosus* Bass.).—Irregularly rounded, hard and woody, with many larval cells inside. On the terminal twigs of swamp white oak (*Quercus platanoides*). Common.

43. **Oak Flake Gall** (*Neuroterus floccosus* Bass.).—Small, hemispherical, covered with white hairs. Found in numbers on the under side of leaf of swamp white oak (*Quercus platanoides*). On the upper side of the leaf it is indicated by a small, smooth, shining blister-like elevation. Common.

44. **Oak Button Gall** (*Neuroterus umbilicatus* Bass.).—Small, rounded, much depressed, with a rather deep cavity on top, in the center of which is a minute nipple. About $\frac{1}{10}$ in. in diameter. Found in numbers on the under side of leaf of swamp white oak (*Quercus platanoides*). On the upper side of the leaf it is indicated by a circular spot. Common.

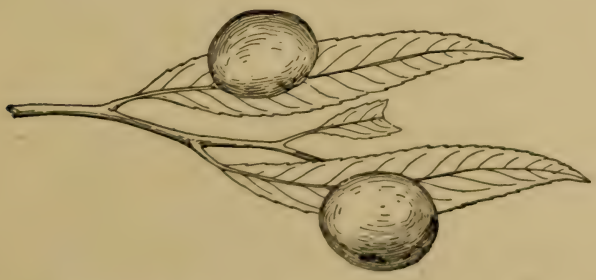
45. **Huckleberry Gall** (*Solenozopheria vaccinii* Ashm.).—Rounded, elongate, concave at place of attachment to the stem, turning the same downward. Green and pithy in summer; brown, hard and woody in winter. On stems of huckleberry. Common.



46. **Lettuce Tumor Gall** (*Aulax tumidus* Bass.).—Varies greatly in shape and size from a slight, knotty and irregular enlargement of the stalk to a large and more or less ovate swelling, 2 to 3 in. long and 1 in. in diameter. Inside it is pithy and filled with many cells. Found on the main stalk of wild lettuce (*Lactuca canadensis*), usually near the summit, often in the panicle itself, and then covered with the short flower stems. Common.

Family Tenthredinidæ (Saw-flies).

With few exceptions the members of this family do not produce galls, the larvæ being leaf-eaters. The larvæ very much resemble the caterpillars of butterflies and moths, but they have, ordinarily, from 12–16 prolegs, while true caterpillars have as a rule only 10. The adult female is furnished with a pair of saws at the end of the abdomen which she uses to make slits in the leaves and stems of plants in which she places her eggs.



47. **Willow Apple Gall** (*Nematus pomum* Walsh).—Rounded and fleshy, somewhat resembling a miniature apple. Yellowish green, usually with a rosy cheek. Measures about ½ in. in diameter. On leaves of bush willow. July and August. Rather common.

DIPTERA (Flies).

Family Cecidomyiidæ (Gall-gnats).

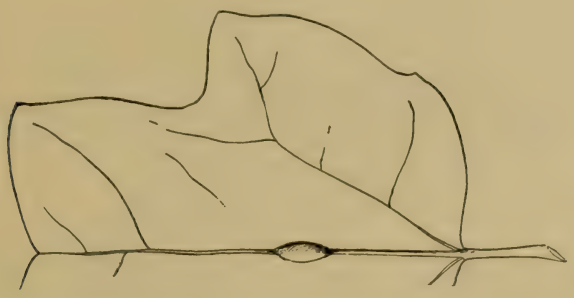
The members of this family are minute flies with the wings and body clothed with long hairs. The larvæ are small brightly-colored maggots, being red, pink, yellow or orange.

48. **Willow Egg Gall** (*Euura ovum* Walsh).—Oval or elongated. Placed lengthwise on one side of a twig, often in a row of two or more. Hard and woody. On the stems of bush willow growing in swampy places. Rather common.

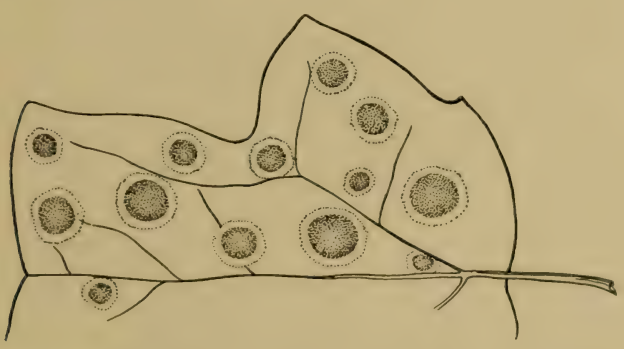
49. **Alder Bud Gall** (*Cecidomyia serrulatæ* Osten Sacken).—Rounded, bud-like, with the apex pointed, and often covered with a whitish bloom. Greenish in autumn and brown in winter. This gall is a deformation of the terminal bud of the common alder (*Alnus rugosa*). Rather common locally.

50. **Basswood Wart Gall** (*Cecidomyia verrucicola* Osten Sacken).—Rounded,

wart-shaped, about $\frac{1}{8}$ in. in diameter. In numbers on the same leaf of basswood (*Tilia americana*). July and August. Rather common.



51. **Tulip-tree Midrib Gall** (*Cecidomyia tulipifera* Osten Sacken).—A small rounded swelling on the midrib of the leaf of the tulip tree (*Liriodendron tulipifera*). Not common.



52. **Tulip-tree Spot Gall** (*Cecidomyia liriodendri* Osten Sacken).—Forms brown spots with a yellow or greenish areola on the leaves of the tulip tree (*Liriodendron tulipifera*). Common.

53. **Wild Cherry Bud Gall** (*Cecidomyia serotinæ* Osten Sacken).—Rounded, club-shaped, with one or two leaves growing from its sides. Bright red in

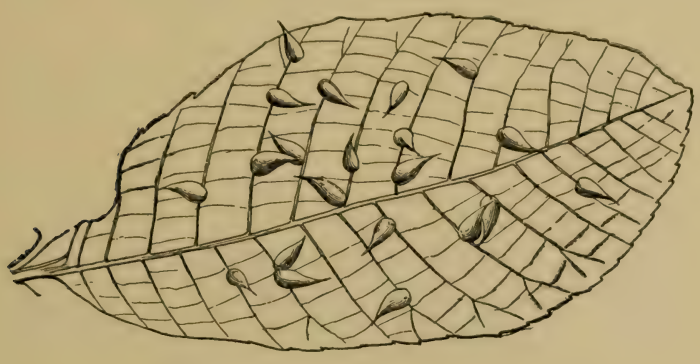
spring; brown in winter. This gall is an enlargement of the terminal bud of young shoots of the wild cherry (*Prunus serotina*). Common.

54. **Ash Midrib Gall** (*Cecidomyia pellex* Osten Sacken).—Rounded, oblong or very much elongated, succulent. Under side indicated by being somewhat swollen. Pale green, sometimes tinged with red. Length from 1 to 2 in. On midrib of leaf of ash (*Fraxinus americana*). May and June. Rather common.

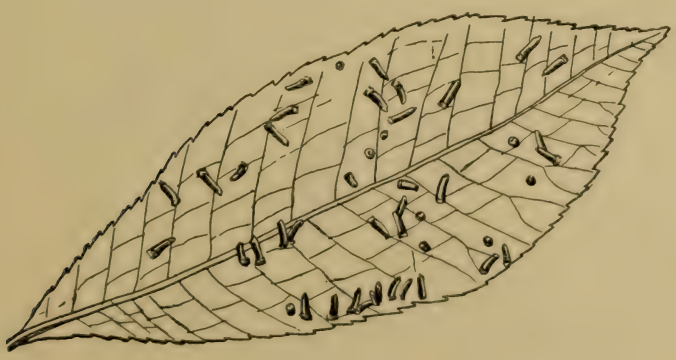
55. **Honey-locust Pod Gall** (*Cecidomyia gleditschiæ* Osten Sacken).—Formed of a single leaflet in such a way as to assume the shape of a small pod. On the leaves of honey-locust (*Gleditschia triacanthos*). Sometimes nearly all the leaves on the terminal twigs are deformed in this way. Not common.

56. **Hickory Onion Gall** (*Cecidomyia holotricha* Osten Sacken).—Sub-

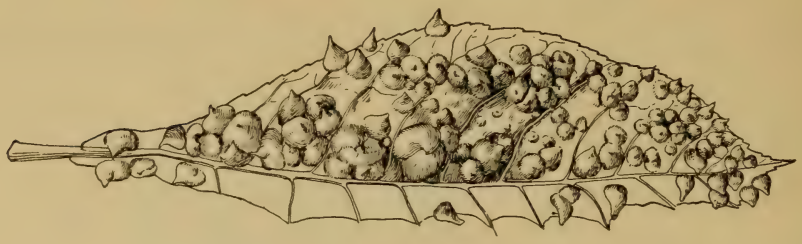
globular, onion-shaped and covered with pubescence which is pale when the gall is young and growing, and becomes rust-colored when mature. Inside it is hollow and contains a single larva. On the under surface of the leaves of different kinds of hickory. Sometimes they cover the entire under surface of the leaf. Very abundant.



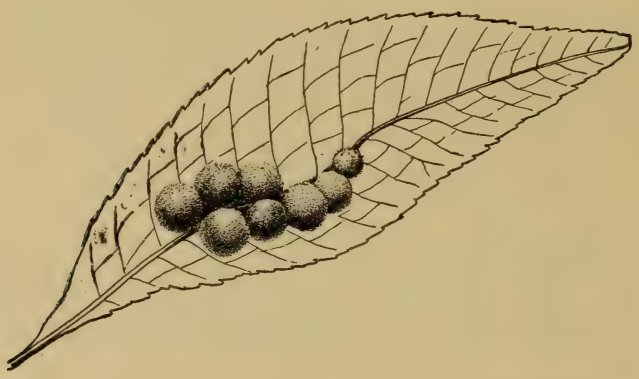
57. **Hickory Seed Gall** (*Cecidomyia caryœcola* Osten Sacken).—Smooth, elongated, rounded, with the tip produced into a point. Pale green. In clusters on the under surface of leaves of different kinds of hickory. Common.



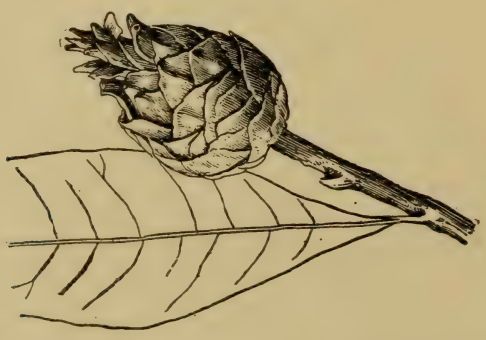
58. **Hickory Tube Gall** (*Cecidomyia tubicola* Osten Sacken).—Narrow, cylindrical, tube-like, inserted in a small protuberance on the leaf, breaking off very easily. Green when immature; black when fully grown. On under surface of the leaves of different kinds of hickory. Common.



59. **Hickory Cone Gall** (*Cecidomyia sanguinolenta* Osten Sacken).—Conical, somewhat narrowed at the base and of a blood red or purplish red color. In numbers on the under surface of the leaves of hickory. Not common.



60. **Hickory Peach Gall** (*Cecidomyia persicoides* Osten Sacken).—Variable in shape, usually rounded and clothed with delicate down like that of a peach, looking somewhat like a diminutive fruit of this kind. On the under surface of the leaves of hickory. Common.

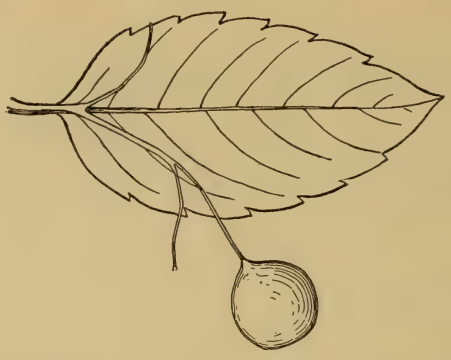


61. **Pine-Cone Willow Gall** (*Cecidomyia strobiloides* Osten Sacken).—Formed of closely imbricated leaves assuming the shape of a cone. On the terminal twigs of different kinds of low willow. Common.

62. **Willow Club Gall** (*Cecidomyia rigidæ* Osten Sacken).—Elongated, club-like, tapering to a point at the apex, and with a number of small terminal buds growing from it. Length about ¾ in. On tips of branches of low willow. Rather common.

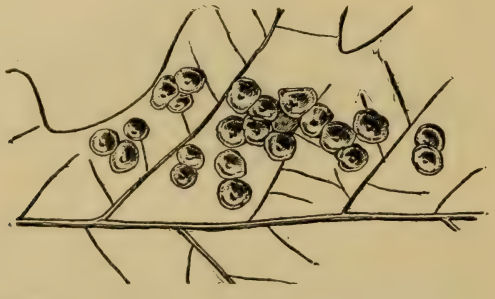
63. **Willow Potato Gall** (*Cecidomyia batatas* Osten Sacken).—Irregularly rounded, varying considerably in size and in shape. Hard and woody. Sometimes the different forms are strung together, one after another, in more or less proximity, on the same twig. On branches of willow (*Salix discolor*). Common.

64. **Dogwood Club Gall** (*Cecidomyia clavula* Beuten.).—Club-shaped and about ½ to 1 in. long. Inside is an elongated channel inhabited by a single larva. Green in summer and the color of the bark in winter. On terminal twigs of dogwood (*Cornus florida*). Common.



65. **Touch-me-not Gall** (*Cecidomyia impatiens* Osten Sacken).—Globular, succulent, semi-transparent, containing a number of cells inside. At base of flower of touch-me-not (*Impatiens biflora*). August. Not common.

66. **Oak Pill Gall** (*Cecidomyia pilulæ* Walsh).—Usually rounded, hard and woody. Frequently two or more galls are confluent and assume a very irregularly rounded or elongated form. Inside are several cells. Brown or green. On upper surface of leaves of different kinds of oak. Very common.



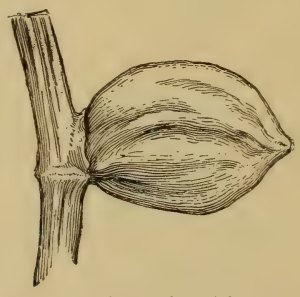
67. **Oak Spangles** (*Cecidomyia poculum* Osten Sacken).—Rounded, saucer-

shaped. Pale red to light lavender. In clusters on under surface of leaf of white oak (*Quercus alba*). August and September. Common.

68. **Oak Fold Gall** (*Cecidomyia niveipila* Osten Sacken).—Consists of a large fold lined with white pubescence. Sometimes the entire leaf is folded with the edges curled, the under side of the leaf being inside of the gall. On red oak (*Quercus rubra*). May and June. Common.

69. **Goldenrod Bunch Gall** (*Cecidomyia solidaginis* Loew).—Produced by the arrest of the stalk, which causes the leaves to accumulate, thus forming a globular bunch, consisting of several hundred leaves. On goldenrod (*Solidago*). Very common.

70. **Grape-vine Tube Gall** (*Cecidomyia vitícola* Osten Sacken).—Narrow, elongated or conical. Green or bright red. In numbers on upper side of the leaves of wild grapes. July and August. Not common.



71. **Grape-vine Apple Gall** (*Cecidomyia vitis-pomum* Walsh and Riley).—Variable in size and in shape, usually rounded, flattened at the base and pointed at the top. When mature the gall often has eight or nine longitudinal ribs, like a muskmelon. Inside are numerous longitudinal cells each divided by a transverse partition. On stems of wild grapes. Common.

72. **Grape-vine Tomato Gall** (*Lasioptera vitis* Osten Sacken).—Consists of a bunch of irregular swellings of various rounded shapes. Soft, juicy and suc-

culent. Yellowish green, tinged with red or entirely of this color. On stems and leaf stalks of wild grapes. May and June. Common.

Family Mycetophilidæ (Fungus-gnats).

The species of flies belonging to this family are of medium or small size and are more or less mosquito-like in form. Most of them feed on fungi and in damp places where there is decaying vegetable matter.

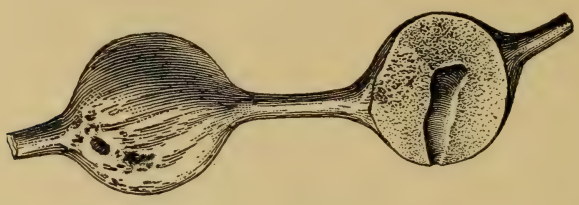
73. **Maple Spot Gall** (*Sciara ocellata* Osten Sacken).—Eye-like, circular, flat. Light yellow, with a red central dot, or entirely green or yellow. In numbers on the leaves of red maple (*Acer rubrum*). Common.

Family Trypetidæ.

Only a certain number of species belonging to this family of flies produce galls. The wings of many of the species are beautifully marked with spots or bands.

74. **Goldenrod Gall** (*Trypeta polita* Loew) —Consists of a small bunch of

accumulated aborted leaves, ½ to ¾ in. long. Caused by the arrest of the side branches. Inside, at the base, is a hollow space in which the larva lives. On stalk of goldenrod (*Solidago altissima*). Singly or in numbers. Common.



75. **Goldenrod Ball Gall** (*Trypeta solidaginis* Fitch).—Globular, ball-like and about 1 in. in diameter. Pithy inside with a rounded cell in the center. On the main stalk of goldenrod. Common.

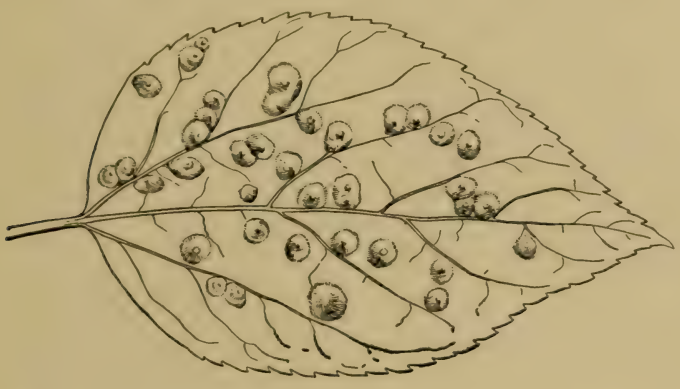
HEMIPTERA (Bugs).

Family Psyllidæ (Jumping Plant-lice).

The insects belonging to this family subsist entirely upon the juices of plants. They are comparatively small, measuring from ⅛ to $\frac{1}{16}$ inch in length. Their hind legs are formed for jumping.

76. **Hackberry Petiole Gall** (*Pachypsylla venusta* Osten Sacken).—Globular or irregularly rounded. Consists of a thin outer shell with several compartments inside. On petiole of the leaf of hackberry (*Celtis occidentalis*). Not common.

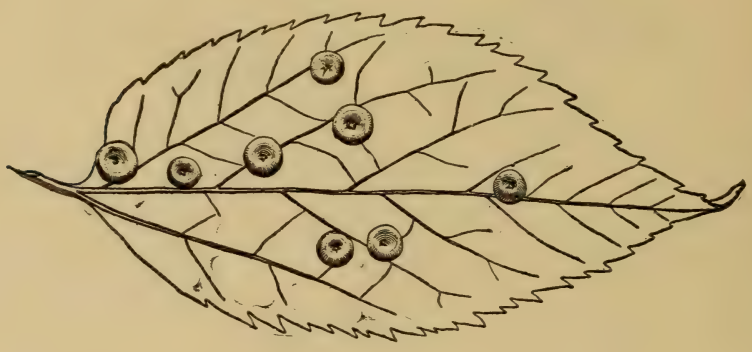
77. **Hackberry Nodule Gall** (*Pachypsylla celtidis-gemma* Riley).—Variable in size and in shape. Bud-like and looking as if formed by the agglomeration of a number of rounded nodules. Hard and woody, with a number of cells inside. On branches of hackberry (*Celtis occidentalis*). It is a deformation of the young bud. Common.



78. **Hackberry Blister Gall** (*Pachypsylla celtidis-vesiculum* Riley).—Circular, flat and blister-like. Convex on the under side with a small nipple in the middle. Green. In numbers on leaf of hackberry (*Celtis occidentalis*). Common.

79. **Hackberry Nipple Gall** (*Pachypsylla celtidis-mamma* Riley).—Repre-

sented by a cup-shaped impression on the upper side of leaf and on the under side it is sub-cylindrical, with the apex rounded bluntly. About $\frac{1}{4}$ in. high and $\frac{1}{8}$ in. wide. On leaf of hackberry (*Celtis occidentalis*). Common.



80. **Hackberry Melon Gall** (*Pachypsylla celtidis-cucurbitæ* Riley).—Under side rounded, truncated at apex and concave in the middle, with a small nipple. Around the top is usually an acute ridge which surrounds the concave depression, and at the sides near the top are short ribs which are sometimes nearly obliterated. Represented by a cup-shaped impression on upper side of leaf. On under side of leaf of hackberry (*Celtis occidentalis*). Common.

Family Aphididæ (Plant-lice).

The plant-lice are well-known insects and infest nearly all kinds of plants. Comparatively few produce galls.

81. **Witch Hazel Cone Gall** (*Hormaphis hamamelidis* Fitch).—A conical swelling on upper side of leaf of witch hazel (*Hamamelis virginiana*). Very common.

82. **Spiny Witch Hazel Gall** (*Hormaphis spinosus* Shiner).—A deformation of the fruit bud, covered with a number of rather long spines, with a funnel-like exit at the base. Green in summer; brown in winter. On witch hazel (*Hamamelis virginiana*). Common.

83. **Cock's Comb Elm Gall** (*Colopha ulmicola* Fitch).—Forms a cock's comb, blubber-like growth on the upper side of the leaf of the elm (*Ulmus americana*). June. Common.

84. **Sumac Tomato Gall** (*Pemphigus rhois* Fitch).—Smooth, rounded,

somewhat resembling a tomato in shape. Inside it is hollow and filled with lice. Yellowish green, tinged with red. On under side of leaf of smooth sumac (*Rhus glabra*) and stag-horn sumac (*Rhus typhina*). Common.

85. **Poplar Stem Gall** (*Pemphigus populicaulis* Fitch).—Irregularly globular, with a mouth-like orifice at the base on one side. On poplar at the junction of the stem and the leaf. Common.

86. **Hickory Louse Gall** (*Phylloxera caryæcaulis* Fitch).—Globular or hickory-nut shape. Hollow inside and filled with lice. When fully grown it bursts open and becomes cup-shaped. Green and leathery. On twigs and leaf-stalks of hickory. May and June. Very common.

ACARINA. (Mites.)

Family Acaridæ.

The members of this order are minute insects closely allied to the spiders. They are parasitic upon animals, man and plants; a certain number produce galls.

87. **Wild Cherry Pouch Gall** (*Acarus serotinæ* Beuten.).—Stem-like, expanding at the end into a pouch-like sack. About $\frac{2}{5}$ in. long. Hollow, with an exit on under side of leaf. Green or red. In numbers on leaf of wild cherry (*Prunus serotina*). Common.

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Marsupials and Small Mammals

in the

American Museum of Natural History

BY

W. D. Matthew, Ph.D.

Associate Curator of Vertebrate Palæontology

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THE AMERICAN MUSEUM OF NATURAL HISTORY was established in 1869 to promote the Natural Sciences and to diffuse a general knowledge of them among the people, and it is in cordial coöperation with all similar institutions throughout the world. The Museum authorities are dependent upon private subscriptions and the dues from members for procuring needed additions to the collections and for carrying on explorations in America and other parts of the world.

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The Museum is open free to the public on Wednesdays, Thursdays, Fridays, Saturdays and Sundays. Admittance is free to Members every day.

FIG. 1. RESTORATION OF MESONYX, A GIGANTIC CREODONT. UPPER EOCENE OF UTAH. BY CHARLES R. KNIGHT. AFTER OSBORN

The Fossil Carnivores Marsupials and Small Mammals in the American Museum of Natural History.

A Guide Leaflet to the Collections

in the

Department of Vertebrate Palæontology.

By

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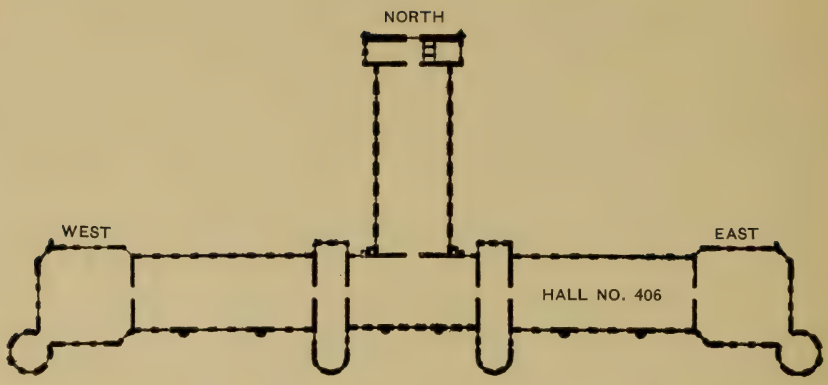

FOURTH FLOOR.

The Collections of Carnivores, Marsupials and Small Mammals upon which this Guide Leaflet is based are exhibited in the northwest quarter of Hall No. 406 of the East Wing, fourth floor of the Museum.

PREFATORY NOTE.

THE collections in the Hall of Fossil Mammals were gathered together under direction of Professor Henry Fairfield Osborn, Curator of the Department, Vice-President and Trustee of the Museum. They are chiefly the result of expeditions to the various Rocky Mountain States, where the richest localities for such specimens are found. These explorations, the funds for which are provided by the generosity of the Trustees of the Museum, have been systematically carried on since 1891. The Cope Collection of Fossil Mammals, purchased in 1894, and various exchange collections from foreign museums, are also exhibited in this hall.

Besides the general guide to the Collection of Fossil Vertebrates, re-issued in October, 1903, a series of special guides, each covering one or more important zoölogical groups, is in course of preparation. These treat of the evolution of each race of animals, and the various problems and theories that are illustrated by the specimens in the hall, more fully than could be done in the general guide.

The present number treats of the Fossil Carnivores, or Flesh-eating Mammals, the Marsupials, or Pouched Mammals, the Rodents, Insectivores, Bats and others, which may be grouped together as Small Mammals. This is the second special guide: the first, treating of the Evolution of the Horse, was published in 1902. Others shortly to appear are on the Titanotheres, the Elephants and the Dinosaurs.

EDITOR.

FOSSIL CARNIVORES, MARSUPIALS AND SMALL MAMMALS

IN THE

AMERICAN MUSEUM OF NATURAL HISTORY.[1]

By W. D. Matthew, Ph.D.

Associate Curator of Vertebrate Palæontology.

I. CARNIVORA.

The Carnivora live principally on the flesh of other animals and have teeth and claws adapted to such food. Most of them, however, eke out their proper food, in times of scarcity, or for mere variety, with berries, nuts, bulbs and roots or even with grass, and some, at certain seasons, find little else available. Carnivores have large canine teeth adapted for cutting or for cutting and chewing, but never for grinding. All of them have claws, and they use their feet in a more varied way than do the Herbivora, for seizing and striking as well as for running and jumping. They walk either upon the entire sole of the foot (bears) or upon the under surface of the toes (dogs, cats etc.), never upon the tips of the toes as do the hoofed animals

There are three divisions:

A, CREODONTA, OR PRIMITIVE CARNIVORA. Extinct land Carnivora with various primitive characters. None now extant.

B, FISSIPEDIA, OR TRUE CARNIVORA. Toes separate; terrestrial or amphibious; preying on land animals. Modern beasts of prey.

C, PINNIPEDIA, OR MARINE CARNIVORA. Web-footed, marine, fish-eating. Seals and Walruses.

Fossil land Carnivora are more numerous and varied than modern kinds. More than 250 fossil species have been described from the United States alone, while but 94 living species are recognized in this country. The majority of the fossil species

[1] This article forms No. 17 of the Museum series of Guide Leaflets and may be obtained in separate form.

fall into one or another of the living families and are more or less directly ancestral to the modern beasts of prey. The remainder belong to several extinct branches, not ancestral to any of the modern families, and are combined in the rather heterogeneous group of Creodonta. Seals and Walruses have not been found fossil, except in the most recent deposits, and nothing is known of their evolution.

A. CREODONTA, OR PRIMITIVE CARNIVORA.

In all modern Carnivora one tooth in the upper and one in the lower jaw are enlarged and especially adapted to the cutting of flesh. Each consists mainly of a high strong crest, or ridge,

FIG. 2. UPPER AND LOWER TEETH OF THE WOLF
Shows the carnassials or flesh-cutting teeth (the fourth premolar in the upper jaw, the first true molar in the lower)

and the two crests, or "blades," work against each other like the blades of a pair of scissors. These teeth are called the "carnassials," or flesh-teeth. In all the modern Carnivora the fourth (last) upper premolar and the first lower true molar are the carnassial teeth. The fossil species show the gradual evolution of this specialized tooth in the various families of Carnivores. In the Creodonta, on the other hand, there is either no carnassial tooth, or it is developed from other teeth of the series,—in one group the first upper and second lower true molars, in another the second upper and third lower molars. (Compare Figures 2, 3, 4 and 5.)

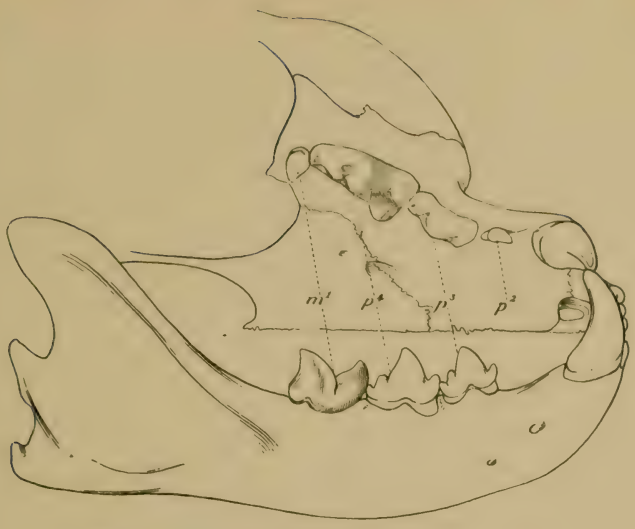

FIG. 3. UPPER AND LOWER TEETH OF THE LION
Shows the carnassials corresponding to those in the Wolf

FIG. 4. UPPER AND LOWER TEETH OF HYÆNODON
Shows the carnassial teeth (second upper and third lower molar)

FIG 5. UPPER AND LOWER TEETH OF OXYÆNA
Shows the carnassial teeth (first upper and second lower molar)

Another characteristic of all modern Carnivora is the union of two bones of the wrist, the scaphoid and lunar, which are distinct in most other animals. This gives additional strength to the thumb side of the very flexible wrist. In the Creodonts, these two bones were separate, and it is probable that they were separate in the earliest ancestors of the true Carnivores. Many

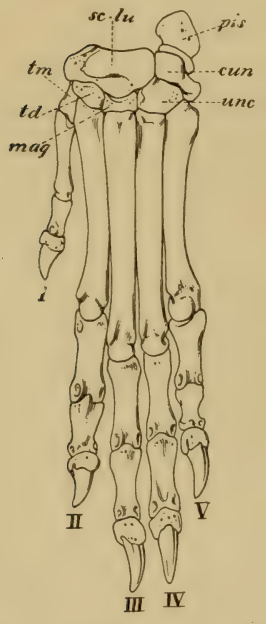

FIG. 6. FORE-FOOT OF THE WOLF
Shows the compact, slender foot, and the scaphoid and lunar bones of the wrist united (*sc-lu*) as in all true Carnivora

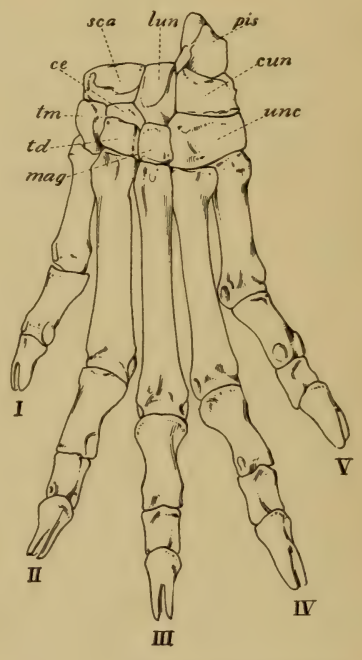

FIG. 7. FORE-FOOT OF HYÆNODON
Shows the shorter and less compact foot, and the separate scaphoid, centrale and lunar bones in the wrist (*sca*, *ce*, *lun*) as in all Creodonta

Creodonts also preserve a small extra bone, the "centrale," which is found now only in monkeys and in certain Insectivora and other small mammals. This bone seems to have been generally present in the ancient mammals.

The most ancient Creodonts are of especial interest to students, because they are thought to represent more nearly than any other fossils known, the central stock from which most modern mammals have descended. They appear already numerous

and varied, at the dawn of the Age of Mammals, and the different kinds become more and more specialized throughout the Eocene epoch. Meanwhile the true Carnivores appear in increasing numbers and gradually crowd out the Creodonts until the last of them has disappeared by the end of the Oligocene epoch. In their evolution the different Creodont groups specialized on much the same lines of development as those the true Carnivores took

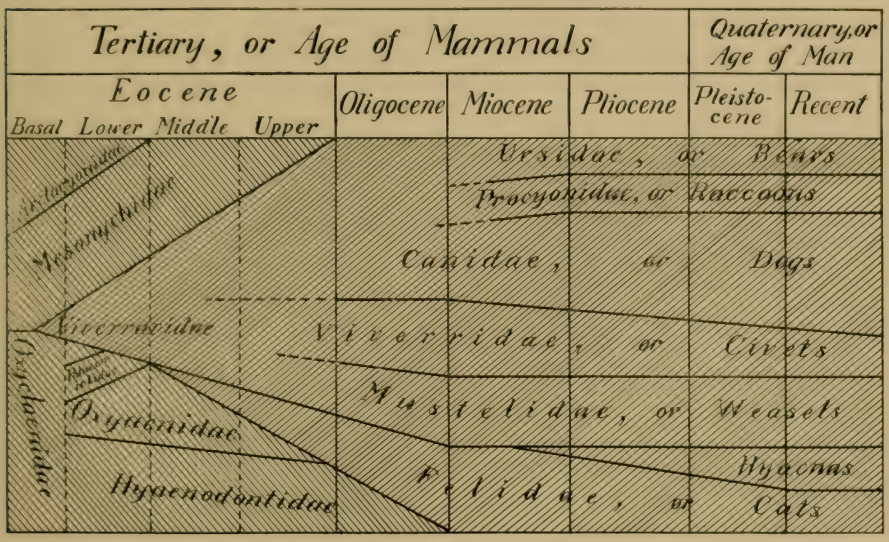

Diagram showing how the true Carnivora crowded out the Creodonta or Primitive Carnivora during the Tertiary Period.

Creodonta. *True Carnivora.*

FIG. 8

afterwards. They were more or less wolf-like, weasel-like, cat-like or bear-like, according to the nature of their food and the manner of attacking their prey.

Fossil remains of flesh-eating animals are by no means as common as those of Herbivora, and the remains of Creodonts are especially rare, and mostly fragmentary. The great majority have been found in the Eocene fossil fields of the Western United States. This Museum is peculiarly rich in these rare and interesting fossils. Out of the 113 American species it possesses all the known specimens of 50 and the types or other good

specimens of 48 others (including three complete mounted skeletons), while only 15 species are not represented.

FIG. 9. UPPER AND LOWER TEETH OF TRICENTES

Represents the most primitive type of teeth of the Carnivora, with no specialized carnassials. Natural size

OXYCLÆNIDÆ.

Types: *Chriacus*, *Tricentes*, *Deltatherium*. Upper and lower jaws.

Small primitive animals with unspecialized teeth resembling those of lemurs. Only fragmentary specimens have been found, and but little is known about them. They are the most ancient group of the Creodonts and appear to have been nearest to the central stock from which the other Creodonts and Carnivores are descended. They are found only in the Basal Eocene.

ARCTOCYONIDÆ.

Types: *Arctocyon*, skull (cast); *Clænodon*, jaws and feet; *Anacodon*, jaws.

Bear-like omnivorous Creodonts with sharp canine teeth and the crowns of the molars flattened and wrinkled on the surface. The animal walked on the entire sole of the foot, and had large sharp claws like the modern bears. As in all these ancient mammals the brain was very small, as can be seen in the skull of *Arctocyon*.

PALÆONICTIDÆ.

Palæonictis, front of skull and jaws.

This rare and primitive group of Creodonts is thought by some authors to be the remote ancestor of the Cat family. It is found only in the Lower Eocene.

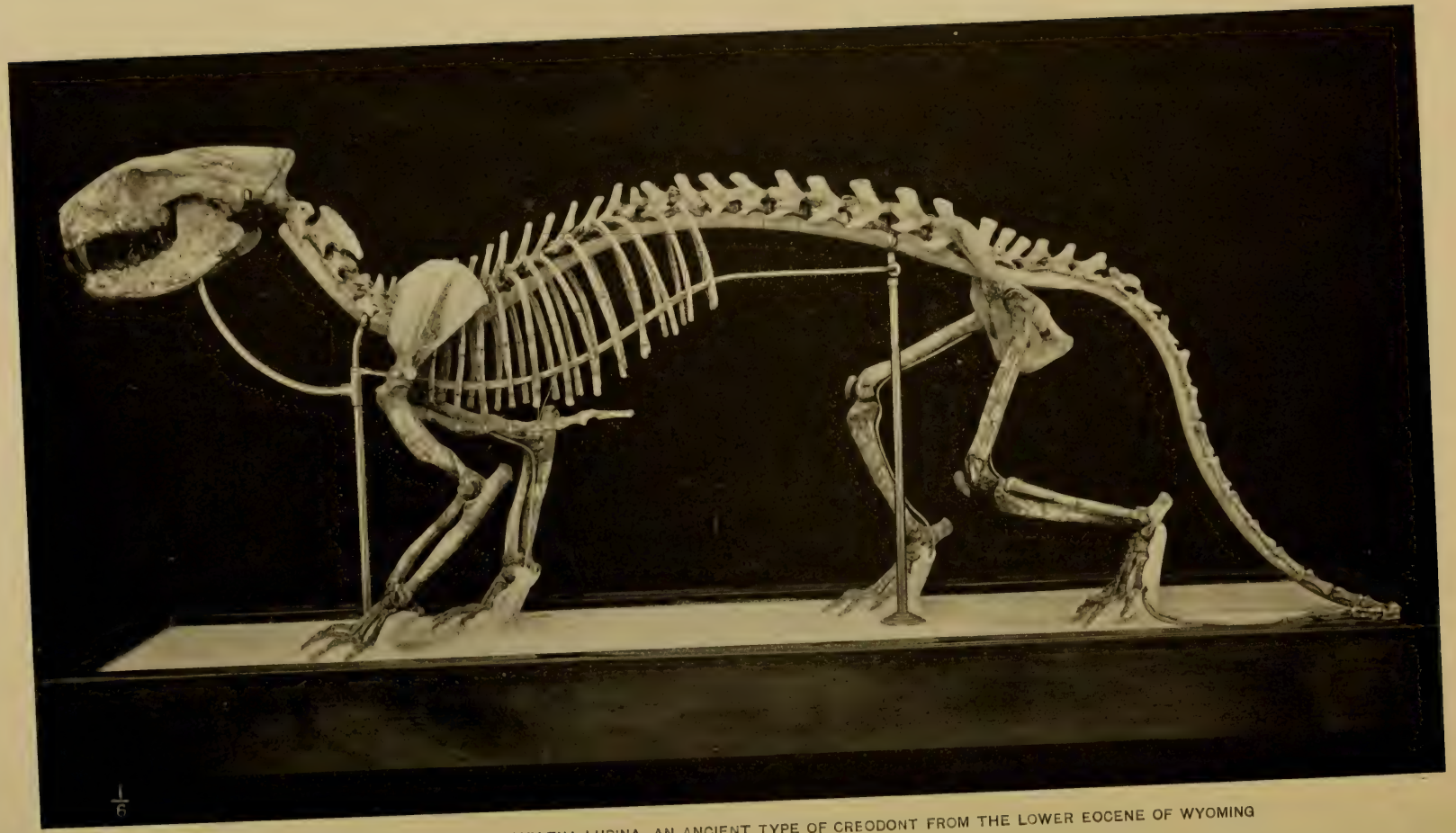

FIG. 10. MOUNTED SKELETON OF OXYÆNA LUPINA, AN ANCIENT TYPE OF CREODONT FROM THE LOWER EOCENE OF WYOMING

One-sixth natural size. After Wortman

Oxyænidæ.

Types: *Oxyæna* and *Patriofelis*, skeletons.

Somewhat resembling the larger Mustelines, such as the Otter and the Wolverine, with short heavy jaws adapted to seize and hold their prey, with long body and with short powerful limbs adapted for leaping, climbing or swimming, but not for swift running. The tail was extraordinarily long, and was larger than in any of the modern Carnivora. The teeth were adapted for flesh-eating, the first upper and second lower molar being enlarged and specialized for cutting the flesh. (See Fig. 5.)

Oxyæna, from the Lower Eocene, was about as large as a Wolverine. The head is disproportionately large, and the tail as long as the entire body and head. The brain-case is very small, and the space for jaw-muscles very large, the whole organization much inferior to that of modern flesh-eaters. Powerful and savage it no doubt was, but far from having the keen intelligence, speed and endurance of the Carnivora of to-day.

The mounted skeleton of this rare animal is due to a fortunate accident. In the Cope Collection there was an incomplete and fragmentary skeleton collected in 1881 in Northern Wyoming by Dr. J. L. Wortman. In 1891 Dr. Wortman, while collecting for this Museum in the same region, discovered another fragmentary skeleton, also incomplete. After the purchase of the Cope Collection by the Museum, these two specimens were compared and found to be parts of the same individual, together constituting a nearly complete skeleton, which has been mounted and placed on exhibition, with the missing parts restored in tinted plaster.

In *Oxyæna* the last upper molar has disappeared, and the second possesses a large shearing blade placed transversely to that of the first molar. In *Patriofelis* of the Middle Eocene the second molar has become very small, and all the flesh-cutting is done by the first molar, shearing against the second lower molar. The teeth are therefore a stage farther advanced in specialization.

The *Patriofelis* skeleton is composed of two individuals of the same species which were found at the same horizon and locality. The animal was about as large as a jaguar, and massively pro-

portioned, with short heavy limbs and broad blunt-clawed feet. It has been thought that *Patriofelis* was of aquatic habits, and more or less nearly ancestral to the Seals; but it was more probably terrestrial, as its teeth indicate adaptation to flesh food, not to fish eating. The limbs and face most nearly resemble those of the short-legged Mustelines, otter, mink etc., among modern animals, and some of these are aquatic or semi-aquatic; but this resemblance may be merely because in both animals the limbs are short and heavy.

HYÆNODONTIDÆ.

Types: *Sinopa*, skull and other parts; *Hyænodon*, skeleton and skulls.

Two groups of animals are included in this family, one represented by *Sinopa*, small long-bodied weasel-like animals with teeth little specialized, suggesting those of the Opossum, the other by *Hyænodon*, which was larger, proportioned more like the Tasmanian Wolf, with teeth highly specialized for flesh-cutting. The first group was probably arboreal, the second terrestrial in habit.

In *Sinopa*, which was characteristic of the Eocene, the crowns of the molars are triangular and each has a longitudinal shearing edge in front and one transverse. In *Hyænodon* of the Oligocene the transverse shear has disappeared completely, the longitudinal shear is concentrated especially on the third lower and second upper molar, the third upper molar has disappeared, and the teeth are as highly specialized for flesh-cutting as those of the living Cats. (See Fig. 3.)

Hyænodon lived during the Oligocene epoch and was the last survivor of the Creodonts. In proportions it singularly resembles the Thylacine, or Tasmanian Wolf, of the rough bush-land of Tasmania. The head is of very large size, with long jaws and large teeth, adapted to snapping rather than seizing and holding on to the prey. The feet had large, rather blunt claws, not retractile, and the animal appears to have walked on the toes, like the dogs and cats, not resting the sole on the ground as do the bears. (See Fig. 6.) A finely preserved skeleton and several skulls from the Big Badlands of South Dakota are mounted in the collection. The largest skull is nearly a foot long.

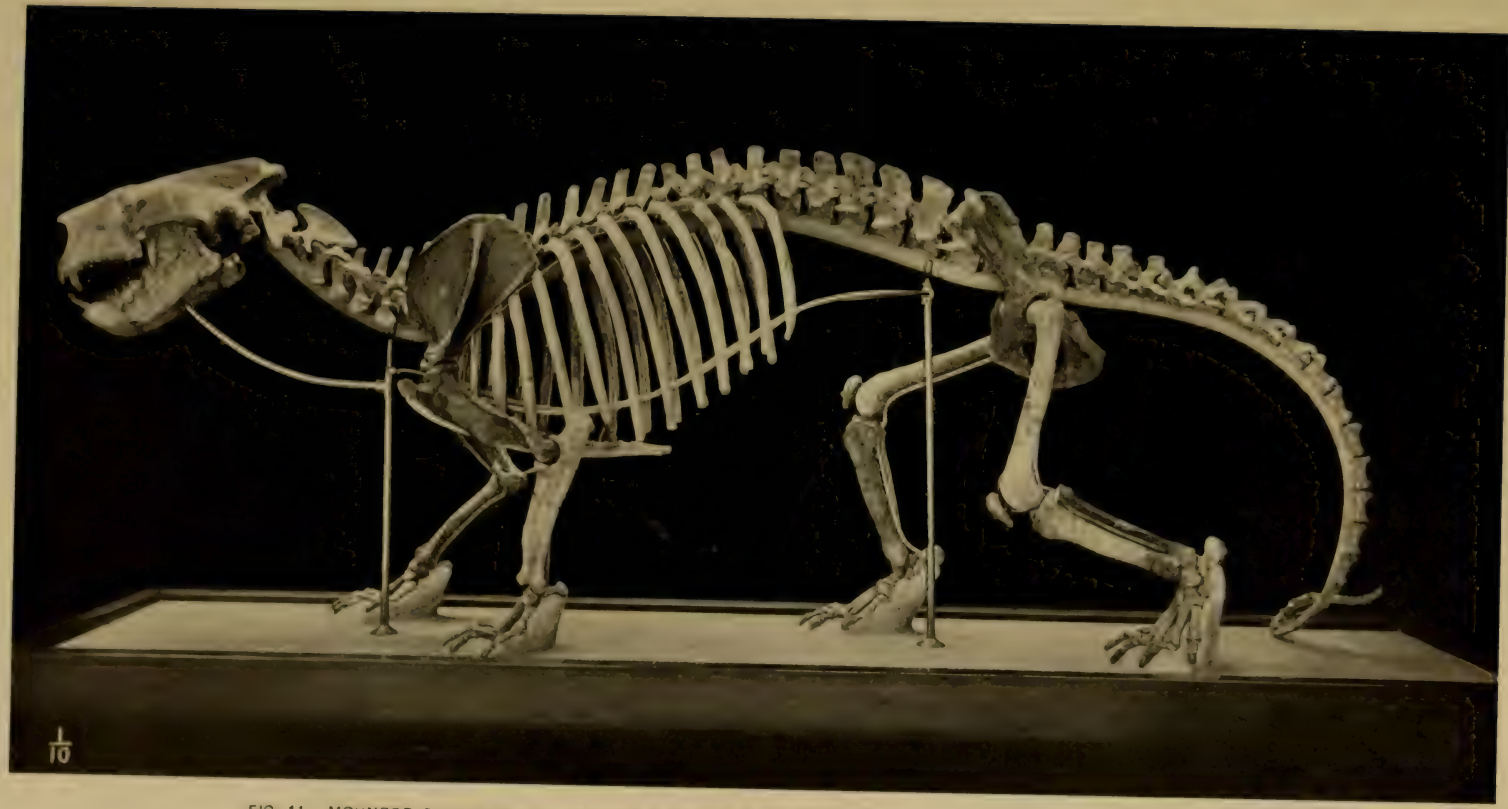

FIG. 11. MOUNTED SKELETON OF PATRIOFELIS FEROX, A CREODONT FROM THE MIDDLE EOCENE OF WYOMING

One-tenth natural size. After Osborn

Mesonychidæ.

Type: *Mesonyx*, skull etc, Wall-case No. 6.

These animals had the limbs and feet specialized for swift running, and the feet tipped with flat hoof-like claws. The teeth are quite peculiar, they have no shearing edges, and the crown is composed of three rather high blunt-topped conical cusps. In

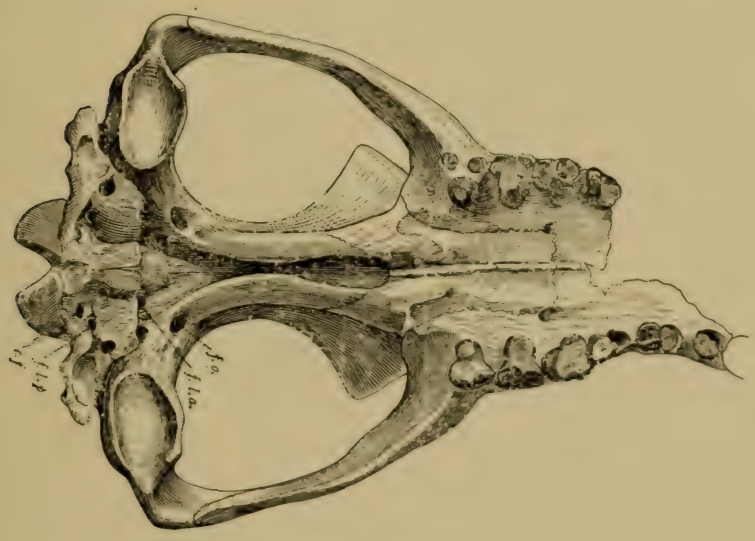

FIG. 12. SKULL OF MESONYX.

Upper Eocene of Utah. After Osborn

the upper jaw these are in a triangle, one cusp inside, two outside; in the lower jaw they are in series, the central one being much the highest.

The Mesonychidæ are found in all the Eocene strata from the oldest to the youngest, and show a series illustrating the gradual evolution of their peculiar type of tooth. The massive blunt-cusped teeth, generally very much worn, suggest that they were used for crushing bones or other hard food, and that the animal fed upon carrion, like the modern hyæna. (See Fig. 1.)

B. FISSIPEDIA, OR TRUE CARNIVORA.

There are seven [1] families of living Carnivora, four of which are cosmopolitan, being found in all the continents except Australia, while one (the Raccoons) is peculiar to America, and two (the Civets and the Hyænas) are peculiar to the Old World. The families are:

1. URSIDÆ, or Bears (Black Bear, Grizzly, Polar Bear etc.).
2. PROCYONIDÆ, or Raccoons (Raccoon and some rarer animals).
3. CANIDÆ, or Dogs (Wolves, Foxes, Jackals).
4. VIVERRIDÆ, or Civets (Civet, Mongoose etc.).
5. MUSTELIDÆ, or Mustelines (Weasel, Otter, Badger, Skunk etc.).
6. FELIDÆ, or Cats (Lion, Tiger, Leopard, Puma, Lynx etc.).
7. HYÆNIDÆ, or Hyænas.

The predaceous animals of Australia and the islands near to it are all Marsupials, or Pouched Mammals, except a wild Dog which was probably introduced by man. The range of the families of true Carnivora in former geological epochs was the same as now, except that South America had no true Carnivores until the Pliocene epoch, their place being taken by carnivorous Marsupials related to those which still inhabit Australia. In general the fossil true Carnivores are placed without difficulty in one or another of the families still surviving; but the earliest known ancestors of all these families were so much alike that it is hardly possible to say in which family they should be placed, and they are conveniently grouped together under the name of VIVERRAVIDÆ, or Ancient Civets, as the Civets among all the modern Carnivores are least altered from the primitive stock. As time went on these primitive Carnivora became more clearly differentiated, so that in the Miocene epoch all the modern families are easily distinguishable. (See Fig. 8.)

[1] Besides these seven families there are a few rare and peculiar Carnivora which are placed in families by themselves, but these are of no geological importance and need not be considered here.

Ursidæ, or Bears.

The Ursidæ, or Bears, are the largest living Carnivora, and are not exceeded in size by any one of the extinct forms. They are less strictly carnivorous than most of the others, since they live in large part upon berries, nuts, roots and other vegetable food. The Polar Bear is an exception, feeding entirely upon animal food, fish and seals. Skulls of two extinct bears are shown in the collection, the Californian and European Cave-Bears.

FIG. 13. TOP VIEW OF SKULL OF PHLAOCYON
A link between raccoons and primitive dogs. Lower Miocene of Colorado. Natural size

These get their name from the fact that their remains are chiefly found in caves, where they hibernated, probably, during the cold season, as do modern bears.

Procyonidæ, or Raccoons.

The Procyonidæ are found only in North and South America, with the exception of the Panda of India, which is doubtfully referred to this family. Fossil raccoons very much like the living species are found in the Pleistocene strata of various parts of the United States, and in cave deposits. In the Oligocene and Miocene epochs lived two more primitive genera which

illustrate the evolution of these animals from the primitive civet-like Carnivora of the Eocene epoch. The Miocene stage, *Leptarctus*, is very little known; only a lower jaw and an upper tooth have been found. Of the Oligocene stage, *Phlaocyon*, a nearly complete skeleton was found in 1898, of which the skull, jaws, limbs and feet are on exhibition. This unique specimen is one of the best preserved fossil Carnivores in the collection. It is intermediate between the civet-like ancestors of the dogs (*Daphænus* and *Cynodictis*) and the modern raccoons. The

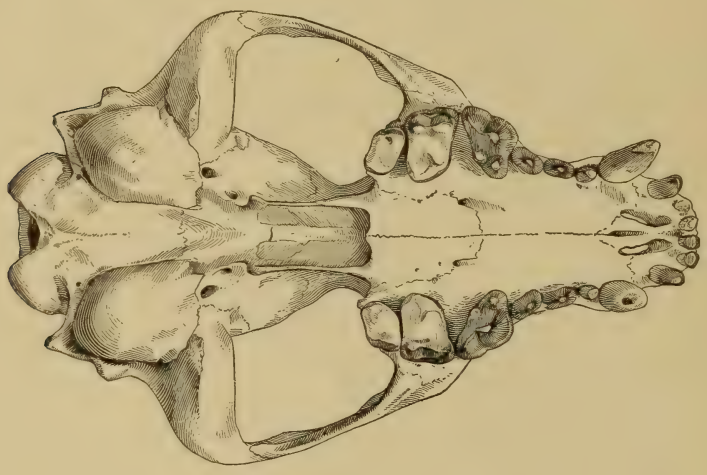

FIG. 14. UNDER SIDE OF SKULL OF PHLAOCYON

A link between raccoons and primitive dogs. Lower Miocene of Colorado. Natural size

shape of the skull is raccoon-like, but the number of teeth is the same as in the dogs, while their form is intermediate between the two types. The limbs and feet are also intermediate. It is probable, therefore, that the Dogs and Raccoons are derived from a common ancestral stock. Specimens found in Europe indicate that the Bears are likewise derived from this common stock, and that the three families have diverged, the Dogs becoming terrestrial flesh-eaters, living largely in open country, the Bears omnivorous and living in the woods, the Raccoons omnivorous and arboreal.

Canidæ, or Dogs.

The living species of Canidæ—Wolves, Coyotes, Foxes—are found only in the most recent deposits (Pleistocene). A great variety of extinct species is known, some of which are the ancestors of modern forms, while others belong to side branches which have not survived. Most remarkable of these side branches were the Amphicyons or Bear-like Dogs, some of which were of huge size, equalling the modern Polar Bear—see skull and backbone of *Dinocyon* in wall-case No. 8. A large series of skulls of vari-

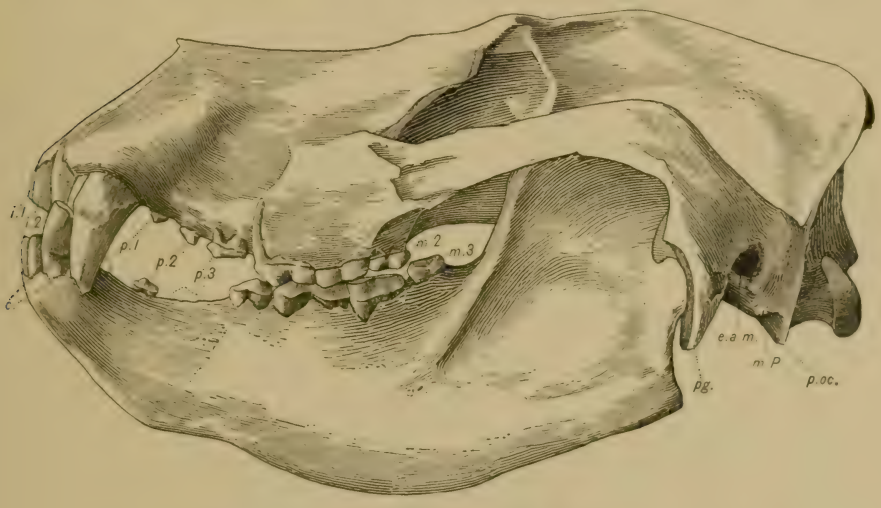

FIG. 15. SKULL OF DINOCYON
A gigantic extinct dog from the Upper Miocene of Texas. One-fourth natural size

ous extinct Dogs of the Oligocene and Miocene epochs is shown in the table-case. These indicate the evolution of the modern species from animals much more like the Civets in proportions and in the character of their teeth. It has been possible to trace out the probable direct lineage of at least two of the modern dogs, the Dhole of India, and certain South American foxes, through these North American fossil species. Other fossil species belong to races of Canids now extinct.

The increase in brain capacity from ancient to modern animals is well shown in this series of skulls. All ancient Dogs had small brains of inferior organization to their modern descendants.

Viverravidæ.

Type: *Viverravus*, skull etc. Table-case.

The Viverravidæ resemble the modern Civets more nearly than any other modern Carnivora. They differ from them in fact in various primitive characters not very noticeable. The brain-case is much smaller in proportion; the scaphoid and lunar bones are sometimes not united; but the form and number of the teeth and proportions of the body were not different from those of modern Civets, except that the skull was larger and the limbs were shorter. They were probably the ancestors of the modern Carnivora, except the Cat family. (See Fig 8.)

Viverridæ, or Civets.

A few specimens of fossil Civets from Europe are shown in the collection. They are not found fossil in America, but it is probable that they are descended, without much change in character, from the Viverravidæ shown in the opposite side of the same table-case.

Mustelidæ, or Mustelines.

Types: *Bunælurus*, *Plesictis*, *Mustela*, *Conepatus*, skulls.

The Mustelines are mostly small or of medium size, savage and blood-thirsty, solitary and forest-loving or aquatic. The Otters are aquatic and live mainly on fish: the Badgers are burrowing animals, and live mainly on burrowing rodents etc.: the Martens, Ferrets and Skunks are arboreal and terrestrial.

These different kinds of Mustelines seem to have separated as early as the Oligocene epoch, for even then we find Martens, Skunks and Otters distinguishable. But they were much more alike then than now, and all of them have many characters linking them with the Civets, indicating that the two families had a common origin. Compare the difference in teeth between *Bunælurus* and *Potamotherium* with the difference between their modern descendants the Marten and the Otter; also compare the *Bunælurus* teeth and skull with those of a civet. Note also the comparatively small brains of the Oligocene Mustelines as *Bunælurus* and *Plesictis*. Their Miocene descendants (*e. g.*, *Mustela ogygia*

skull) had larger brain capacity, and the modern forms still larger and better-developed brains. This indicates that slow but steady

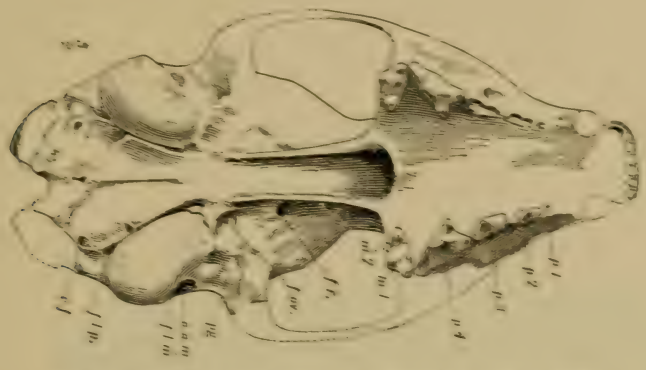

FIG. 16. SKULL OF THE PRIMITIVE MUSTELINE BUNÆLURUS

Oligocene of Colorado. Three-halves natural size. Viewed from the under side to show the teeth

increase in intelligence which has occurred in almost all the lines of evolution among quadrupeds. *Superiority of brain is the final test by which, in the long run, the persistence of a race is decided.*

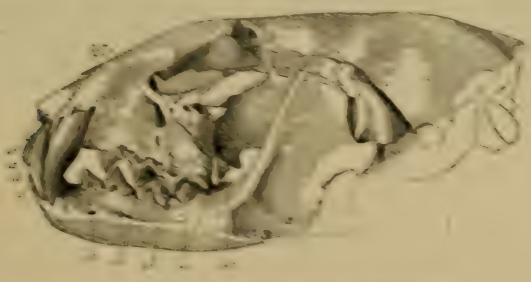

FIG. 17. SKULL OF MUSTELA OBYGIA

An extinct species of marten, from the Middle Miocene of Colorado. Side view, natural size

FELIDÆ, OR CATS.

(Sabre-Tooth Tigers)

Types: the mounted skeletons of *Smilodon* and *Hoplophoneus*, skeleton of *Dinictis* in block; skulls of *Hoplophoneus*, *Dinictis*, *Archælurus*.

Almost all the fossil Cats belong to a division now extinct, in which the upper canine teeth were enlarged into great curving, flattened, sharp-edged tusks, sometimes seven inches long.

Smilodon of the Pleistocene epoch was as large as a polar bear, and exceedingly muscular, especially in the great massive fore-limbs. The claws in the mounted skeleton (upright case) are larger than the largest lion claws. One of the great tusks is complete, the other was broken off during the lifetime of the

F.G. 18. THE GREAT SARBE-TOOTH TIGER, SMILODON
Pleistocene of South America. Restoration by Wolff. Courtesy of Dr. Elliott

animal, for the stump shows evidence of considerable wear after it was broken. This skeleton was found near Buenos Aires in Argentina along with the remains of gigantic ground-sloths (*Megatherium*) and tortoise-armadillos (*Glyptodon*) which may well have been the prey of this most terrible of all the Carnivora. But the Smilodons ranged all over the New World, and like the nearly allied *Machœrodus*, which was distributed over all the northern continents, were contemporaries of primitive man. Whether our palæolithic ancestors ventured to contend with this gigantic foe, we do not know, but the structure of its skeleton indicates that, although more powerful than the lion and the

tiger, it was not nearly so active and intelligent, and that it was fitted to prey upon the slow-moving giant pachyderms of the Quaternary rather than upon active, alert and intelligent animals, least of all perhaps upon man. In the extinction of the Sabre-Tooth Tiger we may rather regret the passing away of a singular and magnificent type of the beasts of prey than rejoice over the disappearance of a dangerous enemy to the human race.

The ancestral Sabre-Tooth Tigers of the older geological epochs were smaller and less specialized. The skeleton of *Hoplophoneus* illustrates their general character and size. This is the most perfect specimen in the collection, every bone being present, and all, with a few unimportant exceptions, complete and perfectly preserved. *Hoplophoneus* was proportioned somewhat like a leopard, but with shorter smaller limbs and very short spreading feet. *Dinictis* had longer limbs, but the teeth were less specialized. *Archælurus* and *Nimravus* were more primitive types, linking the Sabre-Tooth with the ancestors of the true Cats.

FIG. 19. SKULL AND LOWER JAW OF DINICTIS
Primitive Sabre-Tooth Tiger from the Oligocene of Colorado. One-half natural size

Habits of the Sabre-Tooth Tigers. The modern great Cats kill their prey usually by biting it in the neck so as to break the spinal column. They pursue as a rule the long-necked, thin-skinned

ruminants, which are the most abundant herbivores of to-day, seldom molesting the short-necked, thick-skinned pachyderms such as the rhinoceros and the elephant. The Sabre-Tooth appears to have used his great canine fangs in a quite different method of attack; the whole structure of the animal indicates that he struck them forcibly into the side of his prey, the mouth gaping wide meanwhile, and then presumably withdrew them with a ripping, tearing stroke, leaving a great gash whereby a

FIG. 20. THE HEAD OF SMILODON. OUTLINE RESTORATION
To show the widely gaping jaw. By Chas. R. Knight

large animal would soon bleed to death. By this method he would be peculiarly fitted to attack the great pachyderms, with which his exceptional muscular strength especially fitted him to cope while his lack of speed and agility would render him much less dangerous to the swift-footed ruminants and horses of the time. We may infer therefore that, while the true Cats were evolved to prey upon the larger swift running quadrupeds and developed speed and agility to catch their prey, the Sabre-Tooth was evolved to prey upon the powerful and massive contingent of the Herbivora, and developed enormous muscular strength and peculiar weapons of attack to cope with these animals.

The true Cats are not common as fossils, and our collections

contain only a few fragmentary specimens. They can be traced back as far as the Oligocene epoch, without any great change in character, but their earlier history is a blank. It appears probable that they are derived along with the Sabre-Tooth Tigers from some undiscovered group of Creodonts more nearly related to *Palæonictis* than to any other known fossil type.

Hyænidæ, or Hyænas.

Fossil Hyænas are common in the cave deposits of the Old World, but none have been found in this country. In the older formations of Europe there has been found a series of extinct forms which appear to connect the Hyænas with primitive Civets (*Ictitherium*, *Palhyæna*). These are not represented in our collections.

C. PINNIPEDIA, OR SEALS.

This group of Carnivora is exclusively adapted to marine life. They are found fossil in sediments of marine origin, but are very rare, and nothing is known of their evolution. They are almost unrepresented in our collections. An incomplete skull of an extinct species of Walrus found near Atlantic City, N. J., shows that the range of this animal formerly extended much farther south than now.

II. CHIROPTERA, OR BATS.

The Bats are the only mammals capable of true flight, although there are certain kinds of squirrels, marsupials and the so-called "flying lemurs," which can extend portions of the skin into a sort of parachute to assist them in taking long leaps from bough to bough. The wings of Bats are chiefly an extension of the skin membrane between the fingers, which are greatly elongated; those of birds on the contrary are chiefly composed of feathers which grow from the whole length of the arm and hand, although mainly from the second digit of the hand.

Fossil remains of Bats are exceedingly rare except in cave deposits, and do not teach us much about the evolution of this singular group of mammals. They resemble the Insectivora more than any other

order in teeth and skull, but we know practically nothing of when or how the great wing-membranes were developed, except that they must have been of very ancient origin, for in the Oligocene epoch this feature was as fully formed as now. A few fragmentary jaws and wing bones are shown in the collection.

III. INSECTIVORA.

Hedgehogs, Moles, Shrews etc. Table-case.

Small mammals of rather inferior organization with claws on the toes five digits on each foot, simple teeth with sharp cusps on the crowns and no gnawing teeth.

The Insectivora are an order of animals defeated and disappearing in the struggle for existence, owing to the superior

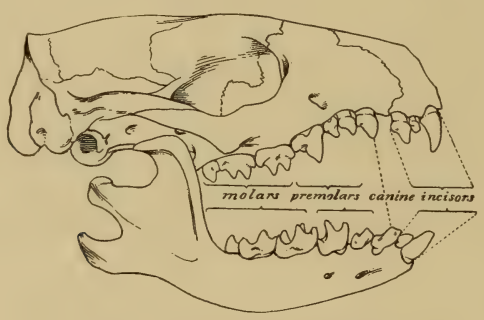

FIG. 21. SKULL OF THE HEDGEHOG.
A surviving type of the insectivora. Natural size

intelligence or better adaptation of their competitors. To escape utter destruction they have been forced into one or another peculiar mode of existence or method of defense, or have been driven to take refuge in the remoter corners of continents or in oceanic islands, where competition is less severe. The Hedgehogs have survived by virtue of their stout and efficient prickly coat, which deters almost any carnivorous animal from meddling with them. The Moles have taken refuge in the earth, where their rivals are few, and they are out of reach of most enemies. The Shrews are partly protected by their unpleasant odor, partly by their small size, nocturnal habits and burrowing or otherwise

concealing themselves. The other Insectivora are inhabitants of the larger tropical islands – Cuba, Madagascar and some East Indian islands – or of South Africa, but have disappeared from the great northern continents, Europe, Asia and North America, where the struggle for existence has been most severe and where all the higher types of mammals have been evolved.

The Insectivora are a very ancient order of mammals, and in past geological periods they were of more importance than now; in fact they have been considered by many scientists as representing more nearly than any other living order the primitive central group from which all other mammals have descended. Through the "Age of Mammals" they progressed less than most other orders and several families of them became extinct during that time, while the Moles and Shrews diverged from nearly similar habits to their present peculiarities, and the Hedgehogs, probably, acquired their coat of spines.

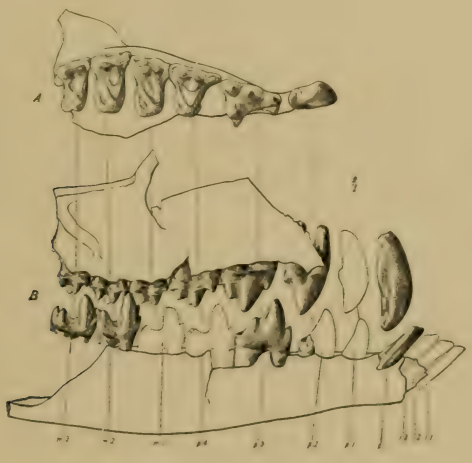

FIG. 22. ICTOPS ACUTIDENS
Upper and lower teeth, showing the "tritubercular" molars. Oligocene Epoch, Montana. Twice natural size

LEPTICTIDÆ, OR PRIMITIVE HEDGEHOGS. Extinct.

Tritubercular molar teeth. Two incisors in upper dentition. Premolars unreduced, the last one molariform. Tibia and fibula fused, ulna and radius separate. Size and proportions like the modern

Hedgehog, skull long and pointed. Eocene and Oligocene epochs, North America.

A series of skulls of these little animals is shown in the table case. They differ from the true Hedgehogs in many archaic characters and there is no reason to suppose that they wore a prickly coat. The "tritubercular" teeth are a primitive characteristic.

ERINACEIDÆ, OR HEDGEHOGS. Living.

Quadritubercular molar teeth. Three incisors in upper dentition. Premolars often small, sometimes reduced in number, the last one molariform. Tibia and fibula united, ulna and radius separate. Skull rather short in the Hedgehog, long and pointed in certain allied East Indian animals. Oligocene to Recent epochs, Europe and America.

Part of the skull of a true Hedgehog of an extinct genus, *Proterix*, from the Oligocene of South Dakota, is shown in the table case, besides jaws of the Miocene genus *Galerix* from Europe.

TUPAJIDÆ, OR TREE-SHREWS.

Living. Borneo.

MACROSCELIDÆ, OR JUMPING-SHREWS.

Living. Africa.

SORICIDÆ, OR SHREWS.

Living. Europe, Asia, northern Africa and North America.

Incisors and premolars reduced in number, the incisors forming a pair of sharp-pointed pincers, molars quadritubercular. No zygomatic arch. Oligocene to Recent. Europe and North America.

More than half of the species of living Insectivora come under this family, but all are of small size, mostly nocturnal, hiding in burrows or beneath leaves or roots during the day. They feed on insects, for which purpose the pincer-like incisors and the sharp little cusps of the molar teeth are well adapted. Fossil Shrews are found in the Oligocene and later formations of both Europe and North America, but only fragmentary remains have been discovered. A few are on exhibition.

Talpidæ, or Moles.

Living. Europe, Asia, northern Africa and North America. Eocene to Recent in Europe and North America.

Completely subterranean; fossorial or burrowing. Incisors not pincer-like. A zygomatic arch present. Fore-limb very short and powerful, specialized for digging.

A small skull of a primitive Mole, *Proscalops*, from the Miocene of Colorado is on exhibition. It is Shrew-like in several respects, showing an approach between the now distinct families of Moles and Shrews. Other fragmentary remains of Moles are shown.

Potamogalidæ.

Living. Madagascar and West Africa. Aquatic animals with long eel-like tails.

Solenodontidæ.

Living. Cuba and Hayti.

Centetidæ.

Living. Madagascar.

Fossil species supposed to be related to these animals are found in the Eocene (*Centetodon*) and Lower Oligocene (*Microp-*

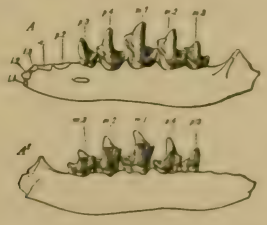

FIG. 23. MICROPTERNODUS BOREALIS

A small and primitive extinct insectivore. Lower jaw, inner and outer view, twice natural size. Oligocene Epoch, Montana

ternodus) of North America. This and the following family are more primitive than any other mammalia in the construction of their teeth.

CHRYSOCHLORIDÆ.

Living. South Africa.

These are known as Cape Golden Moles and take the place of the true Moles in South Africa. A fossil species has been found in the Miocene of Patagonia, indicating that they formerly inhabited both southern continents.

ADAPISORICIDÆ.

Extinct. Lower Eocene. France. Imperfectly known.

DIMYLIDÆ.

Extinct. Lower Miocene. Europe.

Only two molars in upper and lower jaw, the second quite small. Premolars reduced, no canine. Jaws are exhibited in the table-case.

IV. RODENTIA, OR GNAWERS.

Mice, Squirrels, Beavers, Hares, Porcupines etc.

Small mammals with claws on the toes, five digits on each foot, the teeth reduced in number, a pair of upper and lower incisors specialized for gnawing. The gnawing teeth grow continually from per-

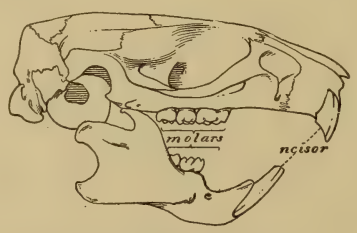

FIG. 21. SKULL OF THE RAT
The most familiar type of the rodentia. Natural size

sistent pulps, during the lifetime of the animal. They have enamel only on the anterior surface and wear to a chisel-like edge which is continually renewed by the more rapid wear of the dentine behind the enamel.

The Rodents are the most numerous group of mammals, but they are almost all small. There are probably now more different

species of rodents than of all the other mammals put together, and they are found in all sorts of places; some are terrestrial, others arboreal, others fossorial or subterranean, others amphibious. They live chiefly on vegetable food, such as grasses, fruit and nuts.

During the Tertiary period Rodents were probably equally numerous; but their remains are so small that they are apt to escape the attention of collectors. Even so they are among the most common of fossil mammals. Most of them belong to families still living.

MURIDÆ. Rats, Mice, Muskrats, Meadow-mice etc.

This is the largest group of the Rodents; there are more than 170 recognized species in North America alone. Several species have been found rather abundant in the American Badland formations. In the White River beds, *Eumys*, allied to the White-footed Mouse, is common; *Paciculus*, allied to the Wood-Rat, is found in the John Day beds; Muskrats and Meadow-mice occur in the Pleistocene.

GEOMYIDÆ. Pocket Gophers.

Found only in North America. Fossil Pocket Gophers occur in the John Day and later formations in the Western States.

HETEROMYIDÆ. Pocket Mice.

Found only in North America. Fossil Pocket Mice are rather common in the White River and John Day formations.

SCIURIDÆ. Squirrels, Prairie Dogs, Woodchucks etc.

Fossil Squirrels, not easily distinguishable from the modern forms, are found in the Oligocene and later formations of the United States. Prairie-Dogs occur in the Pleistocene.

HAPLODONTIIDÆ, OR SEWELLELS. Oligocene to Recent.

The Sewellel, or Mountain Beaver, is a peculiar little burrowing Rodent found only in the western Coast Region of North

America. A tiny fossil Rodent, *Meniscomys* of the Oligocene epoch, is thought to be ancestral to it.

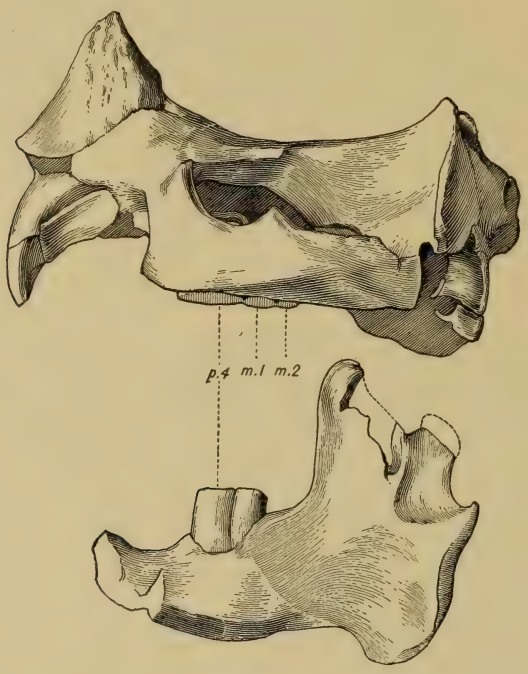

FIG. 25 THE HORNED RODENT, CERATOGAULUS
Skull and lower jaw. Middle Miocene of Colorado. Natural size

MYLAGAULIDÆ. Extinct. Miocene.

Curious little Rodents with digging claws on the fore-feet, very wide short head and peculiar teeth. One skull in the case, the *Ceratogaulus*, or Horned Rodent, shows a large boss indicating a horn on the nose, which gives it an odd likeness to a rhinoceros skull. They are very rare fossils, found only in North America.

CASTORIDÆ. Beavers. Oligocene to Recent.

Fossil Beavers of small size have been found in the Tertiary beds of both America and Europe and several skulls are shown in the collection. In the Quaternary beds are found remains of Beavers scarcely to be distinguished from the living species.

Ischyromyidæ

Extinct. Eocene and Oligocene.

These were Rodents with teeth more or less like Squirrels, but with skulls more like those of Porcupines and Beavers. They are more ancient than any living rodent families, for they were common in the Lower and Middle Eocene, while no other rodents appear until the Upper Eocene. Several skulls and parts of skeletons of *Ischyromys*, *Paramys* etc. are on exhibition.

Castoroididæ.

Extinct. Pleistocene.

Intermediate between beavers and hystricomorphs, but of very large size. *Castor ohioensis* equalled a black bear in size. A skull and jaw of this rare animal are shown in wall case No. 8. Its remains are usually found in bogs, along with those of the mastodon.

South American Rodents.

All the extinct and most of the living Rodents of South America belong to a division more nearly related to the porcupine than to anything else. Some of the living ones, as the Paca and Capybara are of quite large size.

A series of skulls and jaws of extinct rodents from the Miocene of South America is exhibited in the table-case.

There are certain extinct European Rodent families which are thought to be more nearly related to the South American Rodents than to any others, and the remains of several of these forms are exhibited in the case for comparison beside them.

Leporidæ. Hares and Rabbits.

In the White River Badlands remains of fossil Hares are very abundant. They are more primitive than the modern species in the construction of the teeth, and are placed in the genus *Palæolagus* ("Ancient Hare"). In the later formations of America the rabbits belong to the modern genus *Lepus*.

LAGOMYIDÆ. Picas, or Tailless Hares.

These are little animals looking like small Rabbits, but have fewer teeth. They are found in high mountain regions in the Old World and likewise in western North America. They have

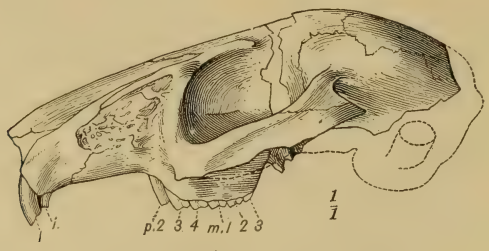

FIG. 26. SKULL OF PALÆOLAGUS
An ancestor of the hares. Oligocene of Colorado. Natural size

been found fossil in Europe, but in America occur only in the latest geological epoch; in the Old World they seem to have taken the place of the true Hares, which were limited to the New World until the end of the Tertiary period.

V. MARSUPIALIA.

All the living marsupials are inhabitants of Australia and the adjacent islands, except the Opossums and a rare genus of Rat-

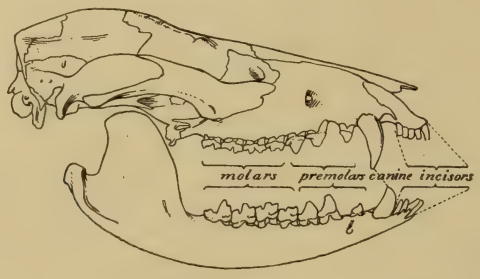

FIG. 27. SKULL OF THE OPOSSUM
Shows the peculiar dentition of the marsupials. Half natural size

Kangaroos from South America. In Australasia they take the place of the mammals of the other continents, none of which occurs

there.[1] Fossil marsupials related to the existing ones of the same region are found in Australia; one gigantic extinct Wombat, *Diprotodon*, is shown in case 6. In South America in the Miocene strata are found remains of various carnivorous marsupials and also of Rat-Kangaroos; a skull and other materials are shown in the collection. In the Eocene and Oligocene of Europe and North America, are found small jaws scarcely to be separated from those of the Opossum except by size. The primitive trituberculates of the Cretaceous period, in the table-case, may also have been marsupials.

VI. MULTITUBERCULATES.

This ancient group of mammals lived during the Age of Reptiles, and became extinct at the beginning of the Age of Mammals. Only jaws, teeth and other fragmentary remains have been found, and it is quite uncertain whether the group is related to the Marsupials or to the Monotremes (*Ornithorhynchus* etc.). Some resemble the Marsupial Rat-Kangaroos, others mimic the Rodents in form. The largest and best known is *Polymastodon* of the basal Eocene; the oldest shown in the case is the tiny *Ctenacodon* of the Jurassic period. *Chirox* and *Ptilodus* of the Cretaceous and basal Eocene are most like the Rat-Kangaroos.

VII. MESOZOIC TRITUBERCULATES.

A number of very small and fragmentary jaws and teeth of Trituberculates from strata of the Jurassic and Cretaceous periods of the Age of Reptiles are exhibited here. They are interesting because they are the most ancient of mammals and show the method of their evolution from reptilian ancestors. Some are thought to be related to the Marsupials, others more nearly to the Insectivores, but until more perfect specimens are found, little can really be stated with certainty about them. Enlarged models of three of these specimens are shown in the case, besides casts and original specimens of many more.

[1] The only exceptions are the dingo, or wild dog, which was probably introduced by man and a few small rodents and bats.

The *Dromatherium* and *Microconodon* casts and models represent two little jaws which are the oldest mammals known. They were found in the Triassic coal-beds of North Carolina, and have a type of teeth intermediate between the primitive three-cusped form of mammals and the simple one-cusped tooth of Reptiles.

THE ORIGIN OF MAMMALS.

The several groups of small and mostly primitive mammals which we have gone over in this guide-leaflet furnish a great deal of evidence, direct and indirect, as to the characters and appearance of the ancestral group or groups from which all mammals are supposed to be descended.

The most ancient mammals, the Multituberculates and Mesozoic Trituberculates of the Age of Reptiles, are known only from rare and very fragmentary remains and many more or less contradictory hypotheses have been advocated as to the relations of these little known groups to the Tertiary mammals which succeeded them and to the lower vertebrates (reptiles and amphibians) which preceded them in geological history. The consensus of present opinion is that mammals in general evolved from an unknown stock of reptiles most nearly related to the Theriodontia [1] which flourished at the end of the Palæozoic era; that they soon split into two branches, one of which (Monotremes) survives without very great change in the egg-laying mammals of Australia. The other more progressive branch again split, one division giving rise to the Marsupials, the other to the Placentals, the latter including all the remaining groups of mammals. The Multituberculates represent a side branch, but whether of Marsupials or of Monotremes is uncertain. The Trituberculates of the Mesozoic era were more nearly in the direct line; some appear to be in the Marsupial branch, others more doubtfully in the Placental branch. But all these conclusions are largely hypothetical.

When we come to the Tertiary mammals, we can speak much more certainly, as these are far more completely known. All the modern races of mammals, as we trace them back towards their

[1] Exhibited in the Hall of Fossil Reptiles, south side.

beginnings, approximate more and more towards a central type which is most nearly represented among known fossils by the earliest Creodonta (Oxyclænidæ) of the dawn of the Tertiary. The Insectivora and Rodentia are also groups of mammals which in most respects have not departed very far from this primitive type. Its general characters are, (1) Small size; (2) Small brain of low organization; (3) Forty-four teeth of simple construction, with sharp cusps, the molars, premolars, canines and incisors of different form, the molars having the "tritubercular" pattern; (4) Limbs and neck flexible and of moderate length, tail very long and powerful, probably prehensile; (5) Feet with five digits on each foot, claws on the toes, the thumb more or less opposable.

These characters appear to indicate an arboreal mode of life rather than any other, and we may suppose that during the Age of Reptiles the ancestors of the mammals were tree-living animals, feeding chiefly upon insects. They were insignificant in size and unimportant in numbers, quite overshadowed by the great and numerous reptilian fauna which flourished during that long era. They possessed, however, the two most important elements of final success in the evolutionary struggle; a brain which, though inferior to that of their descendants, was superior to the brain of all other contemporary vertebrates, and a construction of the joints of limbs and feet more mechanically perfect than in any other animals. By the further improvement and elaboration of these factors of success, they were enabled to displace all their rivals, and become dominant upon land and to some extent upon the sea. Their invasion of the aërial province, already occupied by the highly developed and specialized birds, has been less successful, but of the once dominant reptile fauna of the land, almost nothing remains. The triumphant mammals have branched and re-branched, diverged into countless specializations in adaptation to peculiar modes of life, some of which have survived, while others have become extinct, but always the prime factors of success in the long run have been those which gave them their original advantage over their reptile competitors. Finally the truth that the supremacy in intelligence is first in importance, is best illustrated by the present dominance of man over the whole terrestrial world.

BIBLIOGRAPHY.

This Guide is based principally upon the various scientific studies of specimens in this collection, carried on mostly by members of the staff of this department, which have been published in the Bulletin and Memoirs of the Museum. Upon request, copies of these publications will be loaned to students and others interested in the subject of fossil mammals.

The following books are recommended for collateral reading:

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THE AMERICAN MUSEUM JOURNAL.

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The Mounted Skeleton of Brontosaurus in the American Museum of Natural History.

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A Guide Leaflet to the Collections

in the

Department of Vertebrate Palæontology.

By

W. D. MATTHEW, PH.D.,

ASSOCIATE CURATOR OF VERTEBRATE PALÆONTOLOGY.

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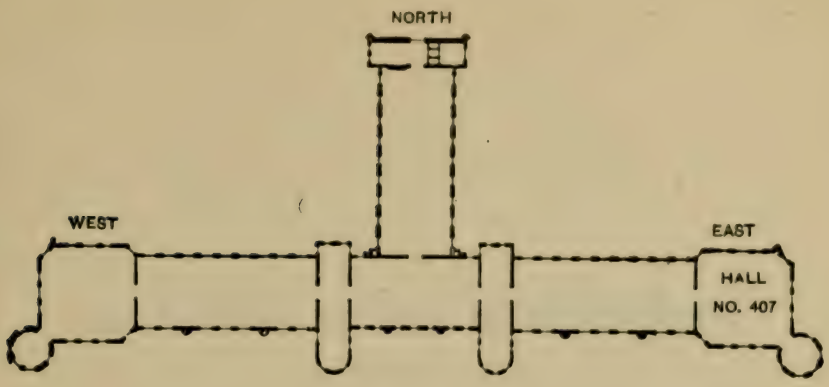
GUIDE LEAFLET No. 18.

REPRINTED FROM THE AMERICAN MUSEUM JOURNAL,

VOLUME V, NO. 2, APRIL, 1905.

New York. Published by the Museum.

FIG. 1. MOUNTED SKELETON OF BRONTOSAURUS IN THE AMERICAN MUSEUM OF NATURAL HISTORY



FOURTH FLOOR.

The Mounted Skeleton of Brontosaurus described in this Guide Leaflet is exhibited in Hall No. 407, the Dinosaur Hall, South-East Wing, fourth floor of the Museum.

PREFATORY NOTE

THE collections in the Dinosaur Hall were gathered together and prepared for exhibition under direction of Professor Henry Fairfield Osborn, Curator of the Department, Vice-President and Trustee of the Museum. They include the Cope Collection of Fossil Reptiles and Amphibians, presented in 1902 by Morris K. Jesup, and the collections brought together by Museum Expeditions to the various Rocky Mountain States where the richest localities for such specimens are found. The funds for these expeditions are provided by the generosity of the Trustees of the Museum.

Besides the general guide to the Collection of Fossil Vertebrates, re-issued in October, 1903, a series of special guides is in course of preparation. Each of these treats of one or more important groups of animals, their evolution, and the various problems and theories illustrated by the specimens in the hall, more fully than could be done in the general guide. Two of these special guides have been published, one dealing with the evolution of the Horse, the other with the Fossil Carnivores, Marsupials and Small Mammals. A special guide to the Dinosaurs is planned, to be issued in three or more sections, which will be prepared as soon as the collections are more permanently and completely installed.

EDITOR.

THE MOUNTED SKELETON OF BRONTOSAURUS.

By W. D. Matthew.

EIGHT years ago the American Museum began a search for fossil reptiles in the Rocky Mountain States. The prime object of the search was to obtain skeletons of the Dinosaurs, those gigantic extinct animals whose fragmentary remains, discovered in that region and studied and described especially by the late Professor Marsh, have excited the greatest interest among men of science. In order to place these marvels of an antique world before the public in tangible form, a Dinosaur Hall was planned, in which should be exhibited mounted skeletons of the principal kinds of Dinosaurs. To obtain these, a series of expeditions into the regions of the arid West, where such fossils are to be found, was inaugurated and carried on under direction of Professor Osborn, and the collections of the late Professor Cope, containing three splendid skeletons of Dinosaurs, were purchased through the liberality of President Jesup.

This programme involved an amount of work hardly to be appreciated by outsiders, and it is as yet far from being complete. Nevertheless, the mounting of the largest skeleton, the Amphibious Dinosaur Brontosaurus, has been finished, the skeleton of a remarkable dwarf Dinosaur, the "Bird-Catcher," has been mounted and placed on exhibition, the preparation and mounting of entire skeletons of three other large and very extraordinary types (the Carnivorous, Duck-billed and Armored Dinosaurs) are well under way, and diligent search is being made for complete and mountable skeletons of other important kinds. Many other more fragmentary specimens have been found, some of which are exhibited in the wall-cases around the hall.

Visitors see here the largest fossil skeleton that has ever been mounted, and may obtain some idea of the variety and the extraordinary character of the animals which populated the earth during the Age of Reptiles, millions of years ago, before the Age of Mammals had begun or the various races of quadrupeds which now inhabit the world had commenced their evolution.

The Brontosaurus skeleton, the principal feature of the hall, is sixty-six feet eight inches in length, and stands fifteen feet two inches high. Its petrified thigh-bone weighs 570 lbs. The weight of the animal when alive is estimated at not less than ninety tons. About one-third of the skeleton, including the skull, is restored in plaster, modeled or cast from other incomplete skeletons. The remaining two-thirds belong to one individual, except for a part of the tail, one shoulder-blade and one hind limb, supplied from another skeleton of the same species.

The skeleton was discovered by Mr. Walter Granger, of the Museum expedition of 1898, about nine miles north of Medicine Bow, Wyoming. It took the whole of the succeeding summer to extract it from the rock, pack it and ship it to the Musuem. Nearly two years were consumed in removing the matrix, piecing together and cementing the brittle and shattered petrified bone, strengthening it so that it would bear handling, and restoring the missing parts of the bones in tinted plaster. The articulation and mounting of the skeleton and modeling of the missing bones took an even longer time, so that it was not until February, 1905, that the Brontosaurus was at last ready for exhibition.

It will appear, therefore, that the collection, preparation and mounting of this gigantic fossil has been a task of extraordinary difficulty. No museum has ever before attempted to mount so large a fossil skeleton, and the great weight and fragile character of the bones made it necessary to devise especial methods to give each bone a rigid and complete support, as otherwise it would soon break in pieces from its own weight. The proper articulating of the bones and the posing of the limbs were equally difficult problems, for the Amphibious Dinosaurs, to which this animal belongs, disappeared from the earth long before the dawn of the Age of Mammals, and their nearest relatives, the living

lizards, crocodiles, etc., are so remote from them in either proportions or habits that they are unsatisfactory guides in determining how the bones were articulated, and are of but little use in posing the limbs and other parts of the body in positions that they must have taken during life. Nor among the higher

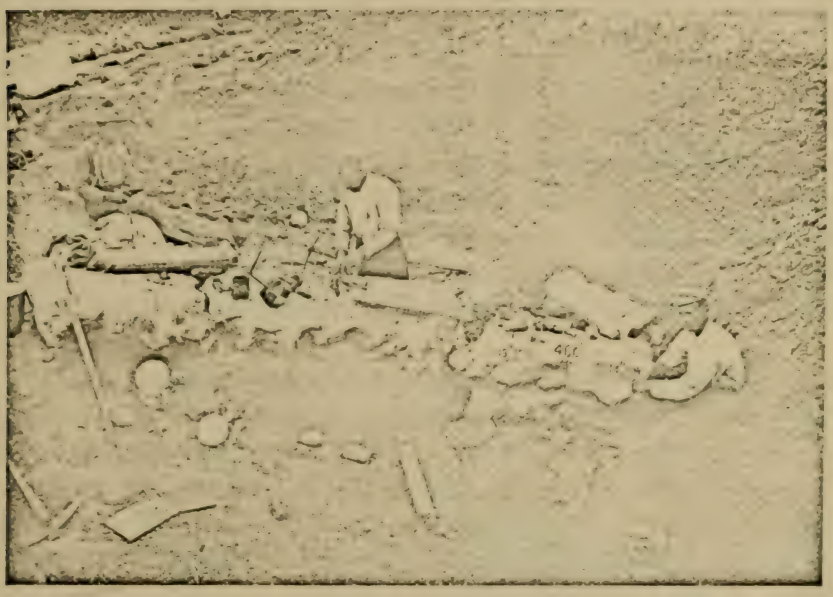


FIG. 2. SKELETON OF BRONTOSAURUS IN THE QUARRY

Showing three sections of the backbone partly covered with plaster bandages for transportation to the Museum. The ribs have already been removed from the near side of the backbone. Tools used in the work lie scattered about the quarry.

animals of modern time is there one which has any analogy in appearance or habits of life to those which we have been obliged by the study of the skeleton to ascribe to the Brontosaurus.

As far as the backbone and ribs were concerned, the articulating surfaces of the bones were a sufficient guide to enable us to pose this part of the skeleton properly. The limb-joints, however, are so imperfect, that we could not in this way make sure of having the bones in a correct position. The following method, therefore, was adopted:

A dissection and thorough study was made by the writer, with the assistance of Mr. Granger, of the limbs of alligators and

other reptiles, and the position, size and action of the principal muscles were carefully worked out. Then the corresponding bones of the Brontosaurus were studied and the position and size of the attachments of the corresponding muscles were marked out, so far as they could be recognized from the scars and processes preserved on the bone. The Brontosaurus limbs were then provisionally articulated and posed, and the position and size of each muscle were represented by a broad strip of paper extending from its origin to its insertion. The action and play of the muscles on the limb of the Brontosaurus could then be studied, and the bones adjusted until a proper and mechanically correct pose was reached. The limbs were then permanently mounted in these poses, and the skeleton as it stands is believed to represent, as nearly as study of the fossil enables us to know, a characteristic position that the animal actually assumed during life.

The Brontosaurus was one of the largest of the Amphibious Dinosaurs or Sauropoda, a race of gigantic reptiles which flourished during the Jurassic or Middle Period of the Age of Reptiles, —some eight millions of years ago by a moderate estimate of geological time. These Amphibious Dinosaurs are more ancient than any of the extinct mammals in the adjoining hall (No. 406), except for a few tiny jaws in the Small Mammal Alcove. They were the largest animals that ever lived, excepting some of the whales, and certainly were the largest animals that ever walked on four legs.

In proportions and appearance the Brontosaurus was quite unlike any living animal. It had a long thick tail like the lizards and crocodiles, a long flexible neck like an ostrich, a thick, short, slab-sided body and straight, massive, post-like limbs suggesting the elephant, and a remarkably small head for the size of the beast. The ribs, limb-bones and tail-bones are exceptionally solid and heavy; the vertebræ of the back and neck, and the skull, on the contrary, are constructed so as to combine the minimum of weight with the large surface necessary for attachment of the huge muscles, the largest possible articulating surfaces, and the necessary strength at all points of strain. For this purpose they are constructed with an elaborate system of

braces and buttresses of thin bony plates connecting the broad articulating surfaces and muscular attachments, all the bone between these thin plates being hollowed into a complicated

FIG. 3. MODEL OF BRONTOSAURUS. BY CHARLES R. KNIGHT, 1905
Executed from the mounted skeleton, under direction of Professor H. F. Osborn

system of air-cavities. This remarkable construction can be best seen in the unmounted skeleton of Camarasaurus, another Amphibious Dinosaur.

The teeth of the Brontosaurus indicate that it was an herbivorous animal feeding on soft vegetable food. Three opinions as to the habitat of Amphibious Dinosaurs have been held by scientific authorities. The first, advocated by Professor Owen, who described the first specimens found forty years ago, and supported especially by Professor Cope, has been most generally adopted. This regards the animals as spending their lives entirely in shallow water, partly immersed, wading about on the bottom or, perhaps, occasionally swimming, but unable to emerge entirely upon dry land. More recently Professor Osborn has advocated the view that they resorted occasionally to the land for egg-laying or other purposes, and still more recently the view has been taken by Mr. Riggs and the late Mr. Hatcher that they were chiefly terrestrial animals. The writer inclines to the view of Owen and Cope, whose unequaled knowledge of comparative anatomy renders their opinion on this doubtful question especially authoritative.

The contrast between the massive structure of the limb-bones, ribs and tail, and the light construction of the backbone, neck

and skull, suggests that the animal was amphibious, living chiefly in shallow water, where it could wade about on the bottom, feeding on the abundant vegetation of the coastal swamps and marshes, and pretty much out of reach of the powerful and active Carnivorous Dinosaurs which were its principal enemies.

FIG. 4. RESTORATION OF BRONTOSAURUS. BY CHARLES R. KNIGHT
This restoration represents Professor Osborn's view of the habits of the animal

The water would buoy up the massive body and prevent its weight from pressing too heavily on the imperfect joints of the limb- and foot-bones, which were covered during life with thick cartilage, like the joints of whales, seals and other aquatic animals. If the full weight of the animal came on these imperfect joints, the cartilage would yield and the ends of the bones would grind against each other, thus preventing the limb from moving without tearing the joint to pieces. The massive, solid limb- and foot-bones weighted the limbs while immersed in water, and served the same purpose as the lead in a diver's shoes, enabling the Brontosaurus to walk about firmly and securely under water. On the other hand, the joints of the neck and back are exceptionally broad, well-fitting and covered with a much thinner

surface of cartilage. The pressure was thus much better distributed over the joint, and the full weight of the part of the animal above water (reduced as it was by the cellular construction of the bones) might be borne on these joints without the cartilage giving away.

Looking at the mounted skeleton we may see that if a line be drawn from the hip-joint to the shoulder-blade, all the bones below this are massive, all above (including neck and head) are lightly constructed. This line then may be taken to indicate the average water-line, so to speak, of this Leviathan of the Shallows. The long neck, however, would enable the animal to wade to a considerable depth, and it might forage for food either in the branches or the tops of trees or, more probably, among the soft succulent water-plants of the bottom. The row of short, spoon-shaped, stubby teeth around the front of the mouth would serve to bite or pull off soft leaves and water-plants, but the animal evidently could not masticate its food, and must have swallowed it without chewing, as do modern reptiles and birds.

The brain-case occupies only a small part of the back of the skull, so that the brain must have been small even for a reptile, and its organization (as inferred from the form of the brain-cast) indicates a very low grade of intelligence. Much larger than the brain proper was the spinal cord, especially in the region of the sacrum, controlling most of the reflex and involuntary actions of the huge organism. Hence we can best regard the Brontosaurus as a great, slow-moving animal-automaton, a vast storehouse of organized matter directed chiefly or solely by instinct and to a very limited degree, if at all, by conscious intelligence. Its huge size and its imperfect organization, as compared with the great quadrupeds of to-day, rendered its movements slow and clumsy; its small and low brain shows that it must have been automatic, instinctive and unintelligent.

COMPOSITION OF THIS SKELETON.

The principal specimen, No. 460, is from the Nine Mile Crossing of the Little Medicine Bow River, Wyoming. It consists of the 5th, 6th and 8th to 13th cervical vertebræ, 1st to 9th dorsal and 3d to 19th caudal vertebræ, all the ribs, both coracoids, parts of sacrum and ilia, both ischia and pubes, left femur

and astragalus and part of left fibula. The backbone and most of the neck of this specimen were found articulated together in the quarry, the ribs of one side in position, the remainder of the bones scattered around them, and some of the tail-bones weathered out on the surface.

From No. 222, found at Como Bluffs, Wyo., were supplied the right scapula, 10th dorsal vertebra, and right femur and tibia.

No. 339, from Bone Cabin Quarry, Wyo., supplied the 20th to 40th caudal vertebræ; No. 592, from the same locality, the metatarsals of the right hind foot, and a few toe-bones are supplied from other specimens.

The remainder of the skeleton is modeled in plaster, the scapula, humerus, radius and ulna from the skeleton in the Yale Museum, the rest principally from specimens in our own collections. The modeling of the skull is based in part upon a smaller incomplete skull in the Yale Museum, but principally upon the complete skull of *Morosaurus* shown in Case 42.

Mounted by A. Hermann; completed Feb. 10, 1905.

AMERICAN MUSEUM OF NATURAL HISTORY

The Reptiles of the Vicinity of New York City

BY

Raymond L. Ditmars

Curator of Reptiles, New York Zoölogical Park

REPRINTED FROM THE AMERICAN MUSEUM JOURNAL

VOL. V, No. 3, JULY, 1905

Guide Leaflet No. 19

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THE AMERICAN MUSEUM OF NATURAL HISTORY was established in 1869 to promote the Natural Sciences and to diffuse a general knowledge of them among the people, and it is in cordial coöperation with all similar institutions throughout the world. The Museum authorities are dependent upon private subscriptions and the dues from members for procuring needed additions to the collections and for carrying on explorations in America and other parts of the world.

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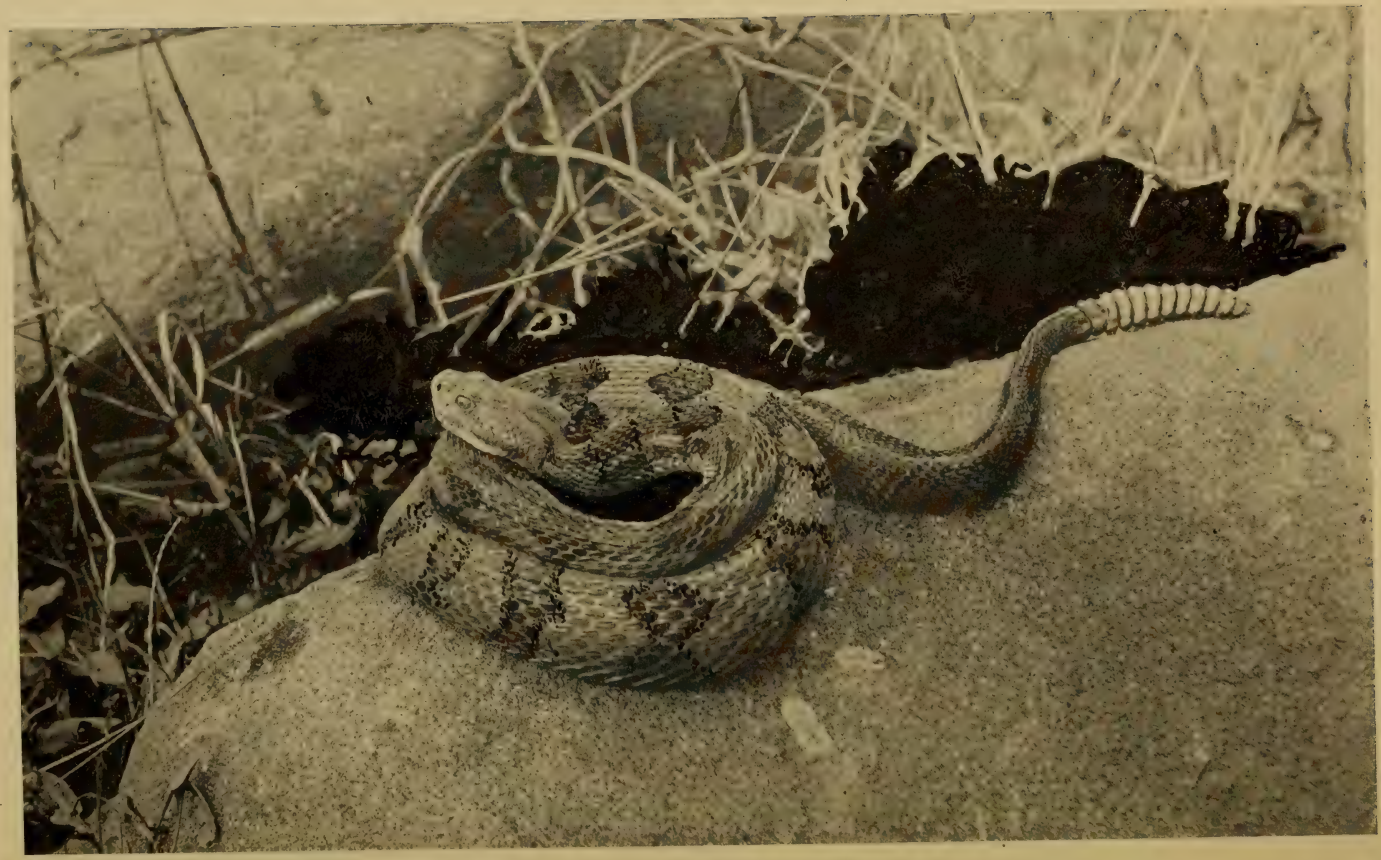

Frontispiece

FIG. 1. BANDED RATTLESNAKE

The Reptiles of the Vicinity of New York City

With Reference to the Collection in the American Museum of Natural History.

By

RAYMOND L. DITMARS,

CURATOR OF REPTILES, NEW YORK ZOÖLOGICAL PARK.

GUIDE LEAFLET No. 19.

REPRINTED FROM THE AMERICAN MUSEUM JOURNAL,

VOLUME V, NO. 3, JULY, 1905.

New York. Published by the Museum.

Prefatory Note.

The Museum gratefully acknowledges the coöperation of the New York Zoölogical Society in the preparation of this Leaflet. The author is Curator of Reptiles at the New York Zoölogical Park, Bronx Park. Through Director W. T. Hornaday the abundant living material of the Zoölogical Park was placed at the disposition of the Museum for the purpose of making photographs for the illustrations; and through Director C. H. Townsend similar courtesies were extended at the New York Aquarium, Battery Park.

Mention should also be made of the valuable assistance rendered by Mr. Herbert Lang of the Museum, who took the photographs from which thirty-seven of the half-tone illustrations (Figs. 4-8, 10-12, 16, 17, 21-47) were prepared. The remaining photographs were furnished by the author.

The collection to which the Leaflet refers may be found at present in the Synoptic Hall, No. 107 of the ground floor of the Museum building. The animals may be seen in the flesh at the Zoölogical Park and the Aquarium.

CONTENTS

PAGE

INTRODUCTION 93

SNAKES 94

KEY TO THE SNAKES 95

DESCRIPTIVE LIST OF THE SNAKES—

Harmless Species:

Worm Snake 97
Milk Snake 98
Ring-Necked Snake 99
Green Snake 100
Black Snake 102
Pilot Blacksnake 103
Hog-nosed Snake 104
Ribbon Snake 106
Garter Snake 107
Water Snake 108
Brown Snake 109
Red-Bellied Snake 110

Poisonous Species:

Copperhead Snake 111
Banded Rattlesnake 113

LIZARDS 115

KEY TO THE LIZARDS 115

DESCRIPTIVE LIST OF THE LIZARDS:

Blue-tailed Lizard 115
Fence Swift 117

TURTLES 119

KEY TO THE TURTLES 119

DESCRIPTIVE LIST OF THE TURTLES:

Leatherback Turtle 123
Loggerhead Turtle 123
Green Turtle 126
Snapping Turtle 126
Mud Turtle 129
Musk Turtle 131
Diamond-back Turtle 131
Painted Turtle 134
Muhlenberg's Turtle 134
Wood Turtle 137
Spotted Turtle 137
Box Tortoise 139

THE REPTILES OF THE VICINITY OF NEW YORK CITY.[1]

By Raymond L. Ditmars,

Curator of Reptiles, New York Zoölogical Park.

Introduction.

In compiling this guide for the identification of the local reptiles, the writer has endeavored to present the subject in a simple and concise manner, avoiding technicalities as far as possible. The usual descriptions of reptiles concern arrangements of the scales upon the head and certain other physical characteristics that are necessarily associated with technical terms, but the keys for identifications and descriptions of the species in the present work appeal principally to the *coloration* and *form* of the reptiles. With but a limited number of species to consider, this plan seems appropriate, since it greatly simplifies the subject.

The reptiles described are those which have been found within a radius of about fifty miles of New York City. Within this section 28 species are represented. Of these species 14 are serpents, 2 are lizards and 12 are turtles. Thus our local fauna may be said to be quite rich in reptile life. In fact, it is within the limits of the area described that certain species of snakes (the Garter Snake, *Thamnophis sirtalis*, and the Brown Snake, *Storeria dekayi*) abound to such an extent that hundreds of specimens are annually killed and captured without apparent decrease in their numbers.

There are but two local species of poisonous snakes, the Banded Rattlesnake and the Copperhead. In certain districts both are fairly abundant, but may be hardly called a menace to mankind, as one is shy and retiring in habits, while the other

[1] Reprinted from *The American Museum Journal*, Vol. V, No. 3, July, 1905.

evinces an unmistakable characteristic of warning. There are but few records of the bites of venomous snakes in this portion of the United States.

SNAKES.

Order *Ophidia*.

The snakes are well represented in the Atlantic states, fourteen species being distributed through sections of the region surrounding New York City. Some of these reptiles attain fair dimensions, and several of the species are brilliantly colored. Two are venomous and of sufficient size to be formidable to man. These dangerous snakes, the Rattlesnake and the Copperhead Snake, may be recognized by their triangular heads which are quite distinct from the neck. The blunt tail of the Rattlesnake, terminating in its warning appendage, is a character hardly possible to be overlooked by the most indifferent observer. The Copperhead Snake is so strongly marked that identification is but the question of a moment's intelligent examination after an idea of the color pattern has been acquired.

Several of our harmless snakes have been provided with eccentric and misleading titles. To those unacquainted with reptiles, such species as the "Flat-headed Adder," the "Spotted Adder," the "Water Moccasin" and others of equally formidable appellation might be regarded as reptiles not entirely devoid of harm. Many of our harmless snakes which are of substantial economic importance in the destruction of the smaller injurious mammals possess the most evil reputation, although they really aid the agriculturist. The slaughter of these useful reptiles by the misinformed is a genuine calamity.

In the key to the identification of the local snakes, the attention of the student is especially directed to *color* and the *formation of scales*. Snakes are either provided with *smooth* or *keeled* scales, the latter having a distinct ridge, or keel, running lengthwise. The Garter Snake and the Water Snake are examples of snakes possessing *keeled* scales. This simple plan makes identification easy, and excludes the usual technical reference to the complicated arrangement of the scales or shields of the head, which requires technical knowledge for satisfactory

comprehension. To aid in this idea, the species are grouped in the key without regard to technical classification.

Key to the Snakes.[1]

a. SCALES SMOOTH.

Size small.

Light brown above; pinkish beneath; snout conical..... **Worm Snake** (*Carphophis amœnus*).

Pale green above; white beneath.... **Green Snake** (*Cyclophis vernalis*).

Dark gray above; a yellow ring around the neck; yellow beneath.. **Ring-necked Snake** (*Diodophis punctatus*).

Size moderate.

Gray, with chestnut saddles above; beneath white, with square spots of black..... **Milk Snake** (*Lampropeltis doliatus triangulus*).

Size large.

Uniform satiny black above; black beneath, with the chin and throat white..... **Black Snake** (*Bascanion constrictor*).

aa. SCALES OF THE BACK FEEBLY KEELED.

Size large.

Black above; beneath white, blotched with gray; scales of the sides show white edges..... **Pilot Blacksnake** (*Coluber obsoletus*).

b. SCALES KEELED.

Size small.

Brown above; pink beneath..... **DeKay's Snake** (*Storeria dekayi*).

Brown or gray above; bright red beneath..... **Storer's Snake** (*S. occipito-maculata*).

Dark brown or black above, with a yellow stripe down the back and a similar stripe on each side on third and fourth rows of scales from underside..... **Ribbon Snake** (*Thamnophis saurita*).

[1] All of the local harmless snakes have eyes with round pupils. The two species of local poisonous snakes have elliptical (cat-like) pupils.

Size moderate.

Dark brown or black above, with a yellowish stripe down the back and a light stripe on each side on second and third rows of scales from underside..... **Garter Snake** (*Thamnophis sirtalis*).

Dark brown or gray above, with reddish transverse bands; white or yellow beneath spotted with red... **Water Snake** (*Natrix fasciata sipedon*).

Dark yellow or brown, with darker transverse markings; snout upturned and sharp..... **Hog-nosed Snake** (*Heterodon platyrhinus*).

Head triangular, distinct from neck.

Light chestnut brown or pinkish-gray, with a series of dark brown transverse bands, narrow on the back and becoming wide on the sides..... **Copperhead Snake** (*Ancistrodon contortrix*).

Yellow, with dark transverse bands; sometimes dark tan or uniform black; tail ending in a rattle..... **Banded Rattlesnake** (*Crotalus horridus*)

FIG. 2. HEAD OF DIAMOND-BACKED RATTLESNAKE. SOUTHERN STATES

Descriptive List of the Snakes.

HARMLESS SPECIES.

FIG. 3. WORM SNAKE

The Worm Snake, *Carphophis amœnus* (Fig. 3), is a diminutive species which, though fairly abundant, is seldom seen, owing to its secretive habits. The Worm Snake is quite characteristic in appearance with its smooth, shining, cylindrical body and sharp snout; the head and neck are of the same width. In color this little serpent is quite somber and in harmony with the surroundings in which it lives. Above, it is light brown or brownish gray; beneath, the color is a delicate shade of pink. In length, the species seldom exceeds eleven inches. **Worm Snake.**

This reptile might possibly be confounded with the Storer's Snake and the DeKay's Snake, which small, retiring species it in a way resembles, principally in color and size, but it may be immediately recognized by its smooth scales; both of the other

species having keeled scales. The Worm Snake frequents damp localities and soft, loose ground, where it burrows with the aid of its sharp snout. Specimens are sometimes found in decaying logs. It is seldom found wandering about above the surface, except among damp leaves or after showers. The food consists largely of earthworms and soft grubs. This snake is oviparous.

Range: Central and eastern United States.

Local distribution: Long Island; Palisades of the Hudson.

FIG. 4. MILK SNAKE

Milk Snake.

The Milk Snake, *Lampropeltis doliatus triangulus* (Figs. 4 and 5), is one of the most brightly colored of the local snakes. The body above is yellowish brown or gray, with a series of irregular chestnut-brown or reddish spots edged with black, about fifty in number; on the sides are smaller spots in alternation with those of the back. Beneath, the reptile is white, with numerous, small oblong spots of black. The length, when mature, is from three to four feet. The scales are smooth and polished.

Although this species is generally distributed, it is not of common occurrence. From a habit of sometimes frequenting the neighborhood of stables and dairies, it has acquired the reputation of obtaining milk from the cows. This is an illogical

FIG. 5. MILK SNAKE; WITH EGGS

theory, and proof of the actual deed from reputable observers is wanting. In captivity this serpent is wholly indifferent to milk, but will eat mice, young birds and small snakes other than its own species. It is a constrictor and closely related to the King Snake of the southern states. The Milk Snake is oviparous, laying eggs to the number of two dozen or more.

Range: The central and eastern United States; Canada.

Local distribution: General; frequents woods.

The Ring-Necked Snake, *Diadophis punctatus* (Fig. 6), is the most easily distinguished of the various local snakes. The scales of this little reptile are smooth and shining, while the body is a uniform dark gray or bluish black, with a brilliant yellow ring around the neck immediately behind the head. Beneath, the color is orange yellow; a single row of black spots is generally present. The length seldom exceeds fifteen inches.

Ring-Necked Snake.

These little snakes may be occasionally found in damp woods, under stones or burrowing under the bark of decaying trees. The species is quite rare within the limits under

consideration, but in some portions of the Hudson Highlands and in the Catskill Mountains it is rather abundant. In the southern states it is very common, the writer having taken several hundred specimens within a few days' time by stripping the bark from old, fallen trees. The Ring-necked Snake feeds largely upon earthworms and the smaller species of salamanders. It is oviparous.

Range: The United States east of the Rocky Mountains; Canada.

FIG. 6. RING-NECKED SNAKE

Local distribution: General.

Green Snake.

Dainty and inoffensive both in looks and habits, the little Green Snake, *Cyclophis vernalis* (Fig. 7), may be easily known by its color which makes it quite distinct from other local species. The color above is a uniform pale green and beneath is light yellow or white. The scales are smooth and possess a satiny luster.

The Green Snake differs from the majority of serpents in being insectivorous. It feeds largely upon hairless caterpillars, although it also consumes crickets, grasshoppers and spiders. The usual length of the animal is about two feet. This species is oviparous.

FIG. 7. GREEN SNAKE

FIG. 8. BLACK SNAKE

Range: The United States east of the Rocky Mountains; Canada.

Local distribution: Common in Rockland, Dutchess and adjoining counties.

Black Snake.

With the exception of one other species, the Black Snake, *Bascanion constrictor* (Fig. 8), attains the largest dimensions of any of the local serpents. Above and beneath, with the exception of the chin and throat, this reptile is a uniform black, the smooth scales imparting to the creature's back a luster similar to that of a gun-barrel. The chin and throat are milky white.

Young specimens show a remarkable variation from the adult snake. Like all the snakes described thus far, the Black Snake is an egg-laying species (oviparous). As is the case with the majority of the oviparous snakes, the eggs are left by the parent to be hatched by the heat of the sun or of decomposing vegetation. At the time of hatching, the young Black Snake belies its name. The body is pale gray with a series of brownish blotches down the back; the head and sides are irregularly spotted with black. At this stage it closely resembles the Milk Snake, but may be distinguished therefrom by the tendency of the blotches on the back to become very narrow as they approach the tail and to disappear almost altogether on that appendage. When a year old, the body color has become very dark, but close inspection will reveal the dorsal blotches. As age progresses the body color becomes darker until it assumes the intense black of the adult.

Extremely agile and feeding upon small rodents, birds, frogs and other snakes, the Black Snake is not a constrictor as its technical name implies, nor is it nearly so courageous as is generally supposed. When surprised, this reptile will invariably take to flight if this be possible, and few serpents can show the speed of this black meteor as it darts away, to stop only when apparent safety is attained. When cornered and escape is cut off, this snake will fight bravely, but the slightest opening is instantly taken advantage of by a dash for cover. The needle-like teeth can produce nothing but the most superficial wounds, yet this serpent is quite generally dreaded. Without doubt the

Black Snake is of value in the woods and fields, since its appetite craves the smaller mammals which are a menace to the agriculturist. The average length of adult specimens is between five and six feet.

Range: The entire United States and southern portions of Canada.[1]

Local distribution: General, in rocky localities.

FIG. 9. PILOT BLACKSNAKE

The Pilot Blacksnake; Mountain Blacksnake, *Coluber obsoletus* (Fig. 9), attains the greatest length of any of the snakes embraced in the present list. This species is a powerful constrictor, and is the northern representative of the large and brilliantly-colored Rat Snakes of the South. **Pilot Blacksnake.**

To the novice this serpent might appear similar to the preceding species. This similarity, however, applies only to color. Unlike the Black Snake or Racer, the scales are polished and the body presents a metallic, shining appearance instead of a satiny luster.

[1] The typical (black) form inhabits the Eastern States; a variety of lighter color frequents the Middle States; in the Western States is the variety called the Green Racer (*B. constrictor flaviventris*).

The general color above is black, the scales of the sides showing white edges when the body is distended. Beneath, the color is white, blotched with gray on the forward portion; posteriorly the gray becomes suffused over the entire surface; the chin and throat are white and immaculate. Close examination will reveal the scales of the back to be faintly keeled, which characteristic at once separates the species from the Black Snake. The head is broad and rather flat; the under surface of the body is so abruptly flattened as to form right angles with the sides.

This species is built rather for climbing than for speed, and generally frequents low bushes, where it lies in wait for birds and small mammals. The species attains a length of more than six feet. It is oviparous.

Range: Eastern United States from Maine to Florida; the Central States; in the South the species extends westward to Texas.

Local distribution: Highlands of the Hudson; not common.

Hog-nosed Snake.

The Hog-nosed Snake, *Heterodon platyrhinus* (Figs. 10 and 11), may be recognized by its sharp, upturned snout, which shovel-like appendage is employed to assist the reptile in burrowing in the sandy soil in which it lives. The markings of this peculiar snake are extremely variable, but the color is generally yellowish brown, with dark brown or black irregular cross-bands. Some specimens show brilliant shades of yellow and red; others are entirely black. The latter constitute the variety *niger*.

The species is stout in body, and the scales are keeled. When annoyed, it assumes a threatening attitude by flattening the head and neck and hissing loudly. In spite of its hostile demeanor, it seldom attempts to bite, but contents itself by endeavoring to frighten the object of its annoyance by its eccentric antics. In different localities the species has been given appellations that have placed this harmless reptile in bad repute. Such names as "Flat-headed Adder," "Blowing Viper" and "Spreading Adder" are energetically used by the farmer who usually refuses to be convinced that this snake is not akin in poisonous faculties to the Copperhead, to which it bears some resemblance in proportions and markings.

FIG. 10. HOG-NOSED SNAKE

FIG. 11. HOG-NOSED SNAKE (VAR. NIGER)

When repeatedly annoyed, this snake will feign death and may then be roughly handled without its displaying signs of life. Its food consists principally of toads. The species is oviparous, depositing about two dozen eggs. A large specimen will measure three feet in length and one and a half inches in diameter.

Range: The United States east of the Rocky Mountains.

Local distribution: Found in nearly all the sandy localities adjacent to New York City. Common on Long Island and the Bayonne peninsula, New Jersey.

FIG. 12. RIBBON SNAKE

Ribbon Snake.

The Ribbon Snake, *Thamnophis saurita* (Fig. 12), is a species which might be easily confounded with the Garter Snake, owing to the similarity of markings. The body color is dark brown or black, with a bright and very clearly-defined stripe of yellow down the back and a similar stripe on each side. The body is very slender and the scales are distinctly keeled. When the skin is distended the sides of the body show small, white spots.

The chief differences between this species and the Garter

Snake are the following: 1. The stripes on the sides are situated on the third and fourth rows of scales from the plates of the crawling surface; with the Garter Snake the lateral stripe is situated on the second and third rows of scales. 2. The underside is immaculate, while the abdomen of the Garter Snake shows a row of small black spots on each side. 3. The Ribbon Snake is, in proportion, considerably more slender than the other species.

The active little Ribbon Snake frequents damp meadows and woods. It seldom exceeds three feet in length. Its food consists

FIG. 13. GARTER SNAKE

of small fishes, tadpoles and frogs. The species is viviparous, but the number of young is small, seldom amounting to a dozen.

Range: Southeastern Canada and the United States east of the Rocky Mountains.

Local distribution: General, but not common.

The Garter Snake, *Thamnophis sirtalis* (Fig. 13), is the most common of our local serpents. The general color above is dark-brown or black, with three yellowish stripes running lengthwise; beneath, the color is greenish yellow. The skin along the sides when distended shows numerous white

Garter Snake.

or greenish spots. The scales are strongly keeled. The species varies in color; specimens are occasionally found upon which the stripe on the back is indistinct or entirely wanting; others present a spotted appearance between the stripes.

Abundant under various conditions of swamp, woods and rocky localities, the Garter Snake will continue to exist within our local borders long after many of the other species of serpents have been exterminated by the ruthless slaughter that unjust prejudice inspires. The species is viviparous, bringing forth as many as thirty or more living young at a brood. The young reptiles feed upon earthworms and grow rapidly. While immature, these snakes are secretive, and the character of their food enables them to obtain a livelihood without prowling forth into danger. Far different is the case of the active young Blacksnake in seach of mice, as it crosses roads and clearings into the danger zone of stones and clubs.

The adult Garter Snake feeds mostly upon frogs and toads; birds and small mammals are never devoured by this species. The length of a large specimen is about a yard.

Range: North America, southward to Guatemala.

Local distribution: General and common; is found in the large parks of New York City.

Our common Water Snake, *Natrix fasciata sipedon* (Fig. 14), is a variety of a species abundant in the southern states. The body is rather stout, with strongly keeled scales; the color is brown with broad irregular cross-bands of reddish brown which show more distinctly on the sides. The underside is yellowish white, brightly marked with red spots and blotches. The young of this species are quite different from the adult in coloration, the body color being gray with the cross-bands black and very distinct. The adult attains a length of four feet and a diameter of two inches. From two and a half to three feet long, however, is the usual size.

Water Snake.

Always frequenting the vicinity of water, this snake may be seen in numbers along slow-running streams, either sunning itself on the banks or stretched upon the branches of bushes that overhang the water. It feeds upon fishes, frogs and toads. The Water Snake is viviparous, bringing forth as many as forty

or more young at a litter. The young are born during the latter part of August and early in September.

Range: The eastern United States from Maine to North Carolina.

Local distribution: Common near ponds, streams and salt-water marshes.

FIG. 14. WATER SNAKE

Among the local snakes, DeKay's Snake, or Brown Snake, *Storeria dekayi* (Fig. 15), is unique in surviving in localities where the other serpents have long since been exterminated. It is common in many portions of the large city parks, where its secretive habits, diminutive size and quiet colors aid in its protection.

Brown Snake.

In color this reptile is brown or brownish gray above, with a minute series of black spots in pairs usually present down the back; the space between these spots is sometimes of a lighter tint than the body color, producing the appearance of an indistinct stripe in some specimens; beneath, the color is pinkish white. The scales are keeled. The average length of adult specimens is twelve inches.

This snake is most frequently found hiding under flat stones, and in such places the reptile searches for its favorite food, which consists of earthworms.

The Brown Snake is viviparous, producing from fifteen to eighteen young during August. During the first year the young snakes are very dark with a whitish ring around the neck. At this stage they resemble the young of the Ring-Necked Snake,

FIG. 15. DEKAY'S, OR BROWN SNAKE

but they may be distinguished therefrom by their keeled scales. When adult, the average length of the Brown Snake is about fourteen inches.

Range: Canada and the eastern United States from the Atlantic coast westward to Kansas and southward to Mexico.

Local distribution: Common in rocky localities.

Red-Bellied Snake.

The Storer's Snake, or Red-Bellied Snake, *Storeria occipitomaculata* (Fig. 16), closely resembles the Brown Snake, but may be distinguished therefrom by its bright vermilion underside. Down the back of Storer's Snake there is usually a well-defined stripe of a lighter shade than the body color, which is brown or dark gray; occasionally specimens are slaty gray with a light stripe down the back bordered with rows of minute black spots. On such specimens the bright red of the underside is especially intense. It is a smaller species

than the preceding, seldom attaining a length of more than eleven inches. The young are produced alive, and are black with a whitish ring around the neck.

Range: The same as the preceding species, but may extend farther north in Canada.

FIG. 16. STORER'S, OR RED-BELLIED SNAKE

Local distribution: Not found within the immediate vicinity of New York City, but is common northward; occurs abundantly in Orange, Rockland and Putnam Counties.

POISONOUS SPECIES.

The Copperhead Snake, *Ancistrodon contortrix* (Fig. 17), is a strongly marked species and easily determined. The body color is light chestnut brown, sometimes assuming a tinge of pink, crossed with dark, reddish-brown bands, which are narrow on the back and wide on the sides, resembling from above the outlines of a dumb-bell; these bands are darkest at their edges, particularly on the sides of the body. The head is somewhat lighter than the body, usually exhibiting a coppery tinge or a bright hazel brown; the sides of the head are of a still

Copper-head Snake.

paler hue. The line of intersection of the lighter color with the coppery tints of the top begins behind the eye and runs to the angle of the mouth. Beneath, the body is pinkish white, with two rows of reddish-brown blotches; the scales are keeled; the pupil of the eye is elliptical.[1]

Although the head of this serpent is triangular and distinct from the neck, the general appearance of the reptile would not immediately lead the uninitiated to class it as a poisonous snake. Several of our local serpents are quite as heavy in body as the

FIG. 17. COPPERHEAD SNAKE

formidable Copperhead. The Milk Snake, the Hog-nosed Snake and the Water Snake are sometimes confounded with the Copperhead, partly on account of a similarity of pattern, and partly on account of the stout bodies of the last two species. From the Milk Snake the Copperhead may be at once distinguished by its keeled scales; from the Hog-nosed Snake and the Water Snake by the arrangement of the plates under the tail.[2] Beginning from the vent, these broad plates in the harmless reptiles are in two rows; in the Copperhead they are arranged in one row, extending across the underside of the tail like the plates of the belly, with the exception (in some specimens) of a few scattered, divided plates near the tip of the tail. From all the harmless snakes the Copperhead may be distinguished by the presence of a

[1] The eyes of all of our harmless snakes have round pupils.

[2] The sub-caudal plates of all the harmless snakes are in two rows.

pit between the eye and the nostril, a characteristic of the crotaline snakes that has led to their popular title, "the Pit Vipers."

The upper jaw of the Copperhead is provided with two long fangs which fold against the roof of the mouth when the latter is closed. These teeth are hollow and are provided with an opening at the tip for the ejection of poison. They are precisely the same in their formation as the needle of a hypodermic syringe. The poison is secreted in glands behind the reptile's eyes, and is forced through the fangs by muscular contraction during the act of biting.

The Copperhead is the most beautiful of our local snakes, its delicate colors so closely resembling the falling leaves of autumn that it is with difficulty to be distinguished from its surroundings at that time of the year. When annoyed, it imparts a rapid, vibratory movement to the tail, which when among dried leaves produces a distinct rattling, audible for several feet. Its bite is very dangerous, but the snake is not habitually hostile and it prefers flight to combat. When cornered, however, it will fight bravely, striking from a partly coiled position. The food of this snake consists of small mammals, birds and frogs. From six to nine young are produced alive during August or early in September. The tails of the young snakes are bright sulphur-yellow, which tint gradually fades as the reptile matures. A large adult specimen will measure three feet in length.

Range: Massachusetts to Florida, westward to Texas.

Local distribution: Palisades of the Hudson River, northern Westchester, Rockland, Putnam and Orange Counties, N. Y. Prefers thick, damp woods and in some districts (Orange and Rockland Counties) is moderately abundant.

Banded Rattlesnake.

With the rattle as an unvarying characteristic, the dangerous Banded Rattlesnake, *Crotalus horridus* (Figs. 1 and 18), may be instantly recognized. Female specimens are generally sulphur-yellow or brown, with black, or dark-brown transverse bands; the males are usually very dark brown or black with little trace of the bands, except yellow markings that show the location of the borders of the transverse blotches. The scales are roughly keeled. The head is triangular and covered with small, irregular scales.

The young are produced during the latter part of August to the number of about a dozen. They grow rapidly and acquire, on an average, three joints of the rattle every year; the young snakes are born with a single "button" on the tail. The average length of a mature snake of this species is from three and a half to four feet.

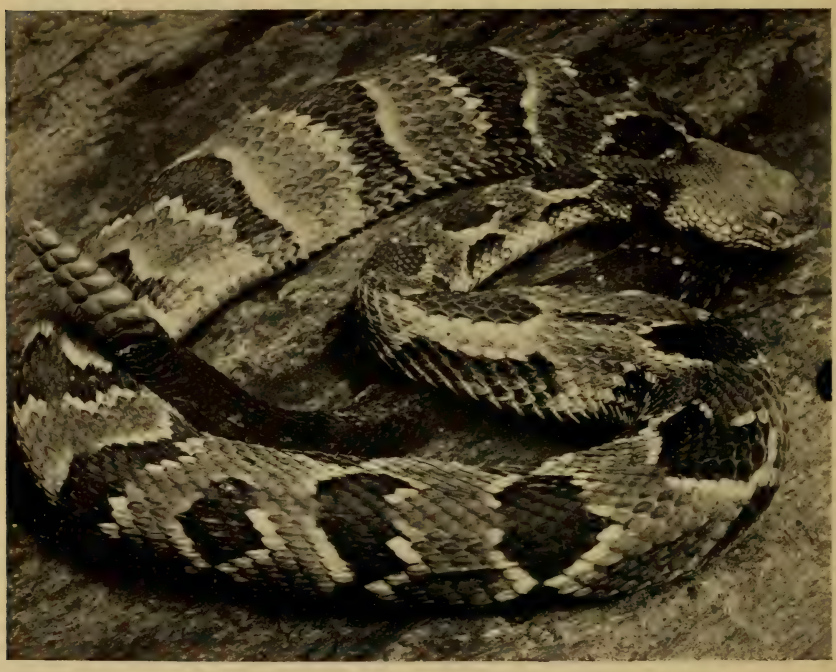

FIG. 18. BANDED RATTLESNAKE

Subsisting upon larger prey, such as squirrels, rats, young rabbits and birds, the Rattlesnake is a bolder reptile than the Copperhead. Provided with proportionately longer fangs and a more virulent poison, the bite of this species is more dangerous than the former. It generally frequents rocky localities and has a wide range of distribution.

Range: Massachusetts to northern Florida, and westward to Texas.

Local distribution: Within fifty miles of New York City, the Rattlesnake is now very scarce. Occasional specimens are reported from Putnam County.

LIZARDS.

Order *Lacertilia*.

The local Lizards, which number two species, are so different in general aspect that immediate identification is possible even to the novice. The smooth, shining Blue-tailed Lizard and the rough, somber-tinted Fence Swift are the examples. The occurrence of the latter species is rare within the limits embraced by this list. Both species are very active, and are insectivorous in habits.

Key to the Lizards.

a. BODY SMOOTH AND SHINING:
Two phases—
aa. Body black, with five yellow stripes; tail blue..... *Young.*
ab. Body brown; stripes indistinct or wanting; head reddish..... *Mature.*
aa and *ab*..... **Blue-tailed Lizard** (*Eumeces quinquelineatus*).

b. BODY ROUGH; THE SCALES KEELED:
Gray or brown with lighter blotches..
Fence Swift (*Sceloporus undulatus*).

DESCRIPTIVE LIST OF THE LIZARDS.

The Blue-tailed Lizard, *Eumeces quinquelineatus* (Fig. 19), is an active species, generally distributed. It may be readily recognized by its smooth, shining scales and bright colors. There are two phases of coloring, one representing young individuals and the other the fully matured animals. Young specimens are black, with five bright

Blue-tailed Lizard.

yellow stripes running lengthwise on the body; the tail of such specimens is usually a brilliant blue,—hence the name. Upon approaching maturity the body assumes a brownish tinge, the stripes become less distinct, and upon the males disappear altogether, while the head takes on a tinge of red. The females retain the stripes, although they are less distinct against the brown body-color than in young specimens; the head of the female is much narrower than the male, while the red tinge upon the same is never so brilliant as in the other sex. The complete color transformation takes about four years.

FIG. 19. BLUE-TAILED LIZARD, YOUNG AND ADULT

The female of this species deposits her eggs, to the number of about a dozen, under the bark of a decaying tree, and coils about the edge of the cluster in serpentine fashion until they hatch. Large specimens of the red-headed form measure eight inches in length. In the South the species grows much larger and is very abundant. The adult males are called "Scorpions."

Range: Southern Massachusetts to Florida; westward to Texas.

Local distribution: General in sunny openings of woods, but not common.

The Fence Swift, *Sceloporus undulatus* (Fig. 20), common everywhere in the southern United States, is very rare within a radius of fifty miles of New York City. In the pine forests of southern New Jersey this agile creature is particularly abundant, and may be seen darting with bewildering speed along fences and fallen trees.

Fence Swift.

FIG. 20. FENCE SWIFT

Unlike the Blue-tailed Lizard, so conspicuous on account of its shining scales, the Fence Swift presents a rough, lusterless surface. The scales are keeled and terminate in sharp, spine-like fashion. The body is rather broad, the head wide. In color this lizard is gray or brown with a series of V-shaped blotches on each side of the body; the underside is dark-gray or black with several large patches of blue. The latter patches vary in intensity according to conditions of temperature and the

activity of the reptile. Six inches is the average length of fully mature specimens.

Range: New Jersey to Florida.

Local distribution: Recorded from the Palisades of the Hudson River and Monmouth County, N. J.

TURTLES.

Order *Chelonia*.

Of the twelve species of turtles, or chelonians, found locally, three are marine wanderers from warmer climes and of rare occurrence. The marine turtles may be immediately recognized by their peculiar paddle-like limbs which are frequently termed "flippers." The use of these members in the progress of a sea turtle through the water has been appropriately compared to the flight of a hawk or an eagle. Of the other species of chelonians, one is strictly terrestrial in habits, while eight species are semi-aquatic and frequent the neighborhood of ponds and marshes.

The upper shell of a turtle is technically known as the "carapace," the lower shell as the "plastron." These terms have been employed throughout the description of the species with a view of abbreviation.

Key to the Turtles.

a. LIMBS LONG AND PADDLE-LIKE (FLIPPERS) ..... **SEA TURTLES.**

aa. Carapace with seven heavy keels, running lengthwise.

Uniform dark brown ..... **Leather-back Turtle** (*Dermochelys coriacea*).

ab. Carapace smooth.

Olive-brown; head very large; usually two nails on each flipper ..... **Loggerhead Turtle** (*Thalassochelys caretta*).

Olive or brown, marbled with yellow; head of moderate size; usually one nail on each flipper ..... **Green Turtle** (*Chelonia mydas*).

b. LIMBS AND FEET WELL DEVELOPED; FEET WEBBED.....**POND AND MARSH TURTLES.**

ba. Carapace smooth.

1. Plastron hinged to close against the carapace.

Dark brown; a yellow stripe on each side of the head....**Musk Turtle** (*Aromochelys odoratus*).

Dark brown; head speckled.**Mud Turtle** (*Kinosternon pennsylvanicum*).

2. Plastron rigid.

Black or olive above; lower edge of carapace brightly marked with red; plastron yellow.....**Painted Turtle** (*Chrysemys picta*).

Carapace black with numerous yellow spots; plastron black, blotched with yellow.....**Spotted Turtle** (*Chelopus guttatus*).

Carapace black or brown, the shields showing lighter borders; head black; a brilliant yellow patch on each side behind the eye..**Muhlenberg's Turtle** (*Chelopus muhlenbergii*).

bb. Carapace showing raised, angular lobes.

Plates of carapace concentrically ringed; light brown above, limbs, neck and fleshy parts salmon red...**Wood Turtle** (*Chelopus insculptus*).

Plates of carapace with numerous concentric rings; color, olive above, head

and limbs gray, profusely spotted with black.....**Diamond-Back Terrapin** (*Malacoclemmys palustris*).

Tail long, partly covered with plates; head very large; color brown or olive.....**Snapping Turtle** (*Chelydra serpentina*).

c. FEET CLUB-SHAPED, NOT WEBBED.....**TORTOISES.**

Carapace high; plastron hinged; color brown, irregularly marked with yellow.....**Box Tortoise** (*Cistudc carolina*).

FIG. 21. HEAD OF LEATHER-BACK TURTLE

FIG. 22. LEATHER-BACK TURTLE

FIG. 23. LEATHER-BACK TURTLE; ON ITS BACK

Descriptive List of the Turtles.

The Leather-back Turtle, or Trunk Turtle, *Dermochelys coriacea* (Figs. 21, 22 and 23), is easily distinguished from the two other species of sea turtles occasionally taken off our coasts, by the heavy, ridge-like processes, seven in number, running lengthwise on the carapace. Instead of the horny plates usually present on turtles, the carapace and plastron of this species are covered with a leathery integument. The Leather-back Turtle attains a large size. In warmer waters specimens are occasionally captured which exceed seven feet in length. The general color is dark brown, although there is sometimes a sprinkling of yellow. Like the other sea turtles this species never comes to the shore, except for the purpose of depositing eggs. Its flesh is of no value for food purposes. The reptile feeds upon fishes, crustacea, mollusks and seaweeds.

Leather-back Turtle.

Range: Tropical seas.

Local distribution: Occasionally off the Atlantic coast of the Middle Atlantic and New England States, where its presence is accidental.

The Loggerhead Turtle, *Thalassochelys caretta* (Figs. 24 and 25), might possibly be confounded with the Green Turtle, owing to a similarity of the shells of these species. Certain characters, however, make determination comparatively simple. The head of the Loggerhead is very large in proportion to the reptile's size; the flippers are generally provided with two nails, while the shell is dark brown, sometimes marked with a lighter brown. The colors of the Green Turtle are much lighter; the head of medium size; there is generally one nail on each flipper. Both of these species have shells covered with smooth shields. The flesh of the Loggerhead is little cared for. It does not deposit eggs in temperate regions. This species attains a length of six feet.

Loggerhead Turtle.

Range: Tropical and semi-tropical seas.

Local distribution: An accidental visitor off the Atlantic coast.

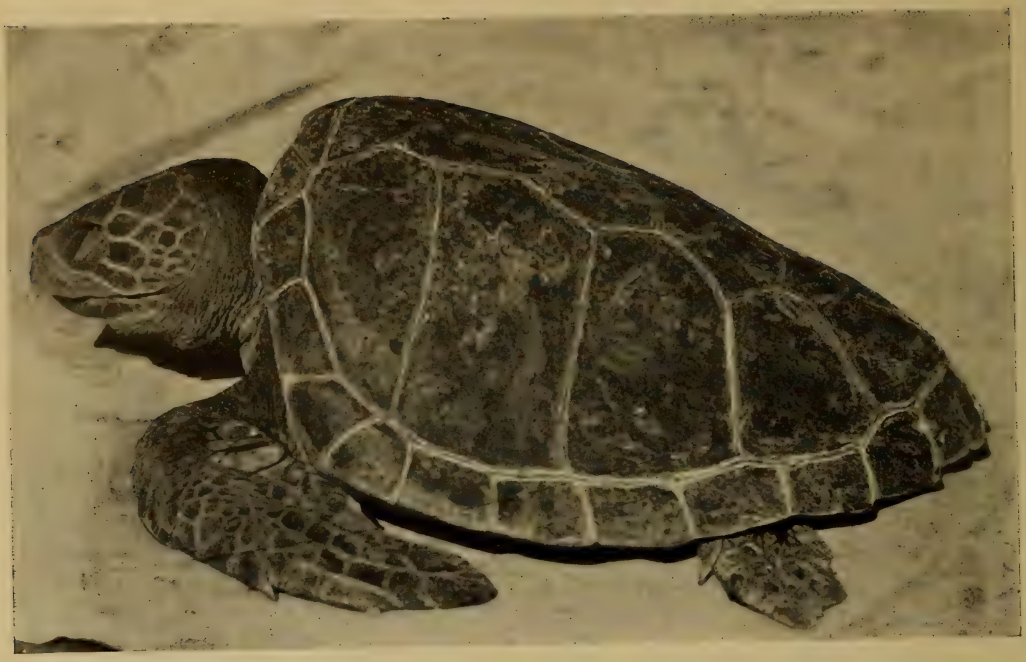

FIG. 24. LOGGERHEAD TURTLE

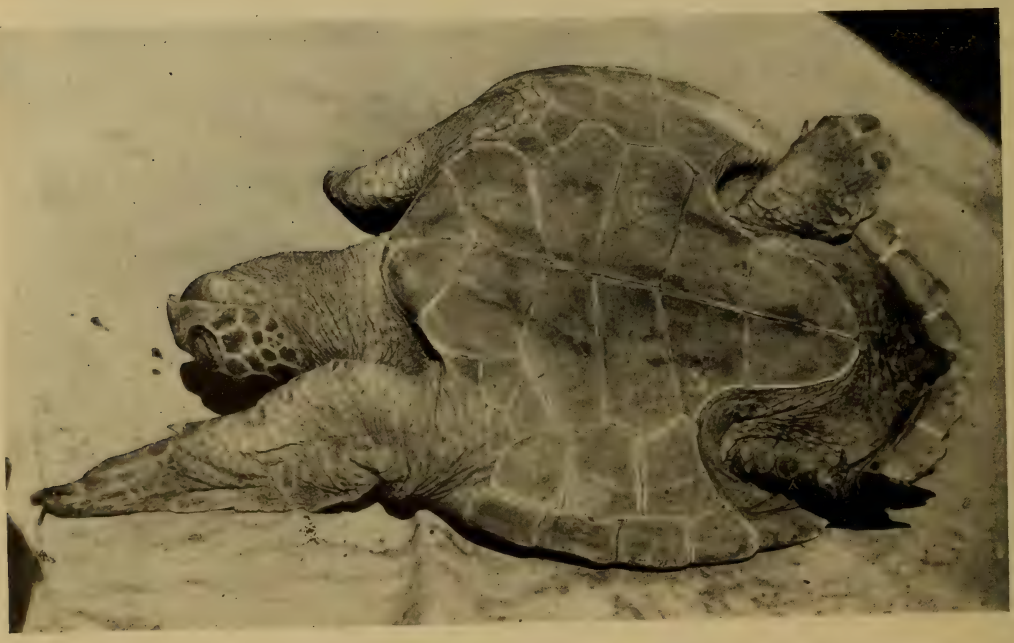

FIG. 25. LOGGERHEAD TURTLE; ON ITS BACK

FIG. 26. GREEN TURTLE

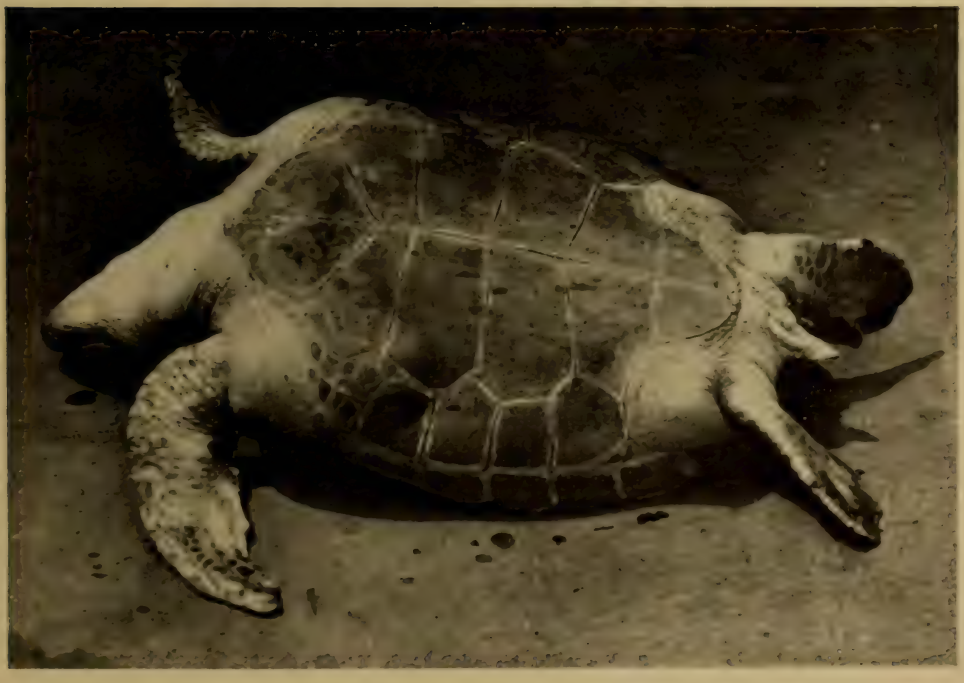

FIG. 27. GREEN TURTLE; ON ITS BACK

The Green Turtle, *Chelonia mydas* (Figs. 26, 27 and 28), is an attractive species, the coloration of the shell being a pale olive, marbled with yellow. The Green Turtle obtains its name from the distinctly green hue of its fat. Highly esteemed as an article of food, these turtles are commonly seen in the markets lying upon their backs, in which position they are helpless.[1] In tropical waters this species is alleged to attain a weight of a thousand pounds.

Green Turtle.

FIG. 28. GREEN TURTLE; HEAD

Range: Tropical and semi-tropical seas.

Local distribution: An accidental visitor off our northern seacoasts.

The Snapping Turtle, *Chelydra serpentina* (Figs. 29 and 30), represents the largest species of our local turtles, excepting the three already described. Its rough carapace of somber brown, with its keels and serrations, and the proportionately huge, sinister head combine to make this creature unique among our turtles. The tail is long and possesses a series of plates which form an alligator-like crest; the carapace is deeply serrated posteriorly. In proportion to

Snapping Turtle.

[1] The majority of the fresh-water turtles, however, when so placed, can readily roll over through the combined assistance of the head and limbs.

FIG. 29. SNAPPING TURTLE

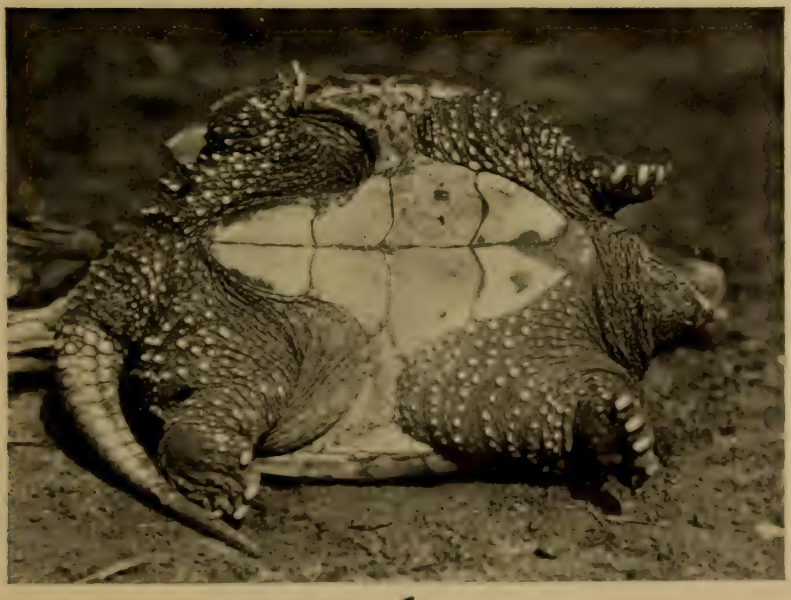

FIG. 30. SNAPPING TURTLE; ON ITS BACK

the reptile's size the plastron is very small and provides little or no protection for the limbs in time of danger. In color the Snapping Turtle is dark brown, with no markings. Adult specimens attain a length of two feet and a weight of from thirty-five to forty pounds. The carapace of old specimens is often covered with moss.

Slow-running muddy streams and large ponds are the lurking places of these reptiles, which are exceedingly voracious. Lying partly hidden in the mud, they await the approach of fish or even young water fowl. Possessed of a pugnacious disposition, a large specimen might well be rated as dangerous. The hooked jaws are capable of inflicting deep wounds, and are, moreover, employed with energy when the reptile is annoyed. When of medium size, the species is said to be edible. The eggs are deposited in June, to the number of from two to four dozen; they are perfectly spherical and possess a hard shell.

Range: Canada and the United States east of the Rocky Mountains; southward to Ecuador.

Local distribution: General and abundant.

FIG. 31. MUD TURTLE

The Mud Turtle, *Kinosternon pennsylvanicum* (Figs. 31 and 32), is often confounded with the Musk Turtle (*Aromochelys odoratus*), which it resembles in shape and size. The principal differences between the two species are in the markings of the head and the width of the plastron. The head of the Musk Turtle shows on each side two distinct, yellowish stripes, beginning at the tip of the snout and running to the neck, and the plastron is very narrow and is much shorter than the carapace, affording little protection. The Mud Turtle, on the other hand, shows no stripes upon the head and neck; the head is irregularly speckled with green or yellow; the plastron is wide, is but a trifle shorter than the carapace, and can be closed to afford substantial protection. The average length of the Mud Turtle in this vicinity is about three and one-half inches when adult. It is not as common as the Musk Turtle.

Mud Turtle.

Range: The eastern United States from New York to the Gulf of Mexico.

Local distribution: General in slow-running, muddy streams and ponds.

The Musk Turtle, *Aromochelys odoratus* (Figs. 33, 34 and 35), may be distinguished from the Mud Turtle, which it closely resembles, by the points given under the preceding caption.

FIG. 32. MUD TURTLE; ON ITS BACK

FIG. 33. MUSK TURTLE

FIG. 34. MUSK TURTLE

In some localities the Musk Turtle is very common, particularly in slow-running rivers with soft, muddy beds. When annoyed, it gives off a musky odor which is strong enough to be offensive. The carapace of an old specimen is usually so overgrown with moss as to be seen with difficulty when the animal is lying in the mud in shallow water, as is its habit. This species is frequently hooked in fresh-water fishing. In many ways the species resembles, in miniature, the Snapping Turtle. From three to four inches is the maximum size.

Musk Turtle.

FIG. 35. MUSK TURTLE; ON ITS BACK

Range: Eastern North America from Canada to the Gulf of Mexico.

Local distribution: General in slow-running streams and ponds. Occurs within the limits of New York City, and is very common in the Bronx River.

None among our turtles is better known, although possibly only by name, than the Diamond-back Turtle, or Terrapin, *Malacoclemmys palustris* (Figs. 36 and 37). The shields of the carapace rise from the surface of the shell in a series of rough, concentric rings; the row of shields down the back shows a broken keel which rises rather sharply in the center of each plate: this condition is especially

Diamond-back Terrapin.

FIG. 36. DIAMOND-BACK TURTLE (TERRAPIN)

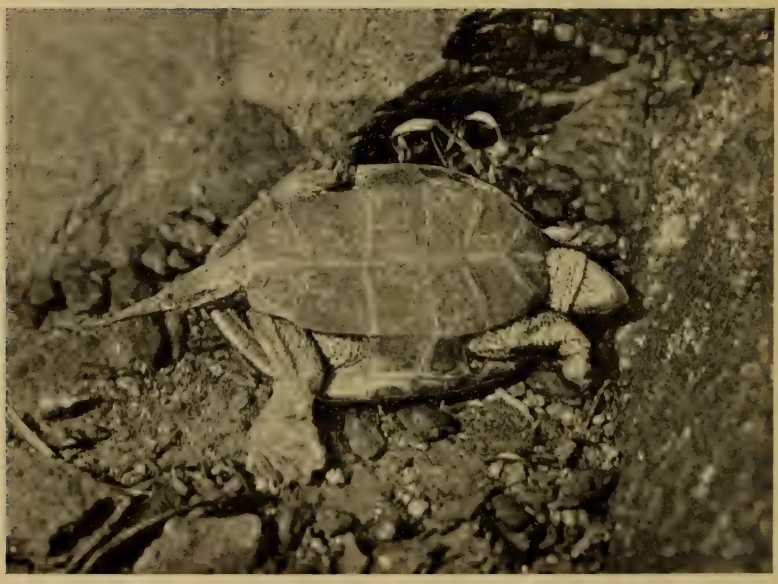

FIG. 37. DIAMOND-BACK TURTLE; ON ITS BACK

FIG. 38. PAINTED TURTLE

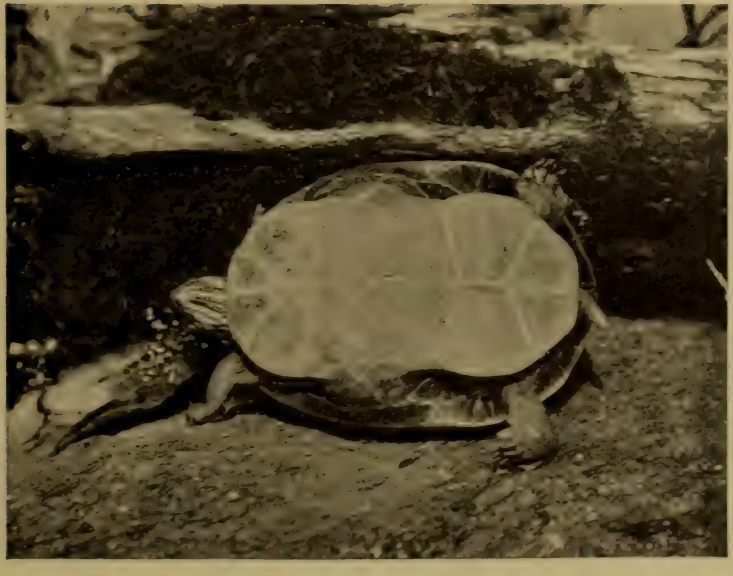

FIG. 39. PAINTED TURTLE; ON ITS BACK

prominent in young specimens and decreases with age and consequent wear of the shell. The color of the carapace is uniform green or olive, although the edges of the plates are sometimes of a slightly different shade. The general color of the limbs, head, neck and tail is pale gray, profusely spotted with black; the plastron is yellow, lined and spotted with gray.

The Diamond-back is the familiar market terrapin, and at certain times of the year sells as high as $70 per dozen. It is becoming rare in the north. Large specimens will measure ten inches in length. This is the only species of local turtle (with the exception of the Sea Turtles) that frequents salt water.

Range: The Atlantic coast from New York to Florida.

Local distribution: Salt marshes in the vicinity of Long Island Sound, Staten Island and New Jersey.

The Painted Turtle, *Chrysemys picta* (Figs. 38 and 39), is one of the most common of the local species and is easily recognized.

Painted Turtle.

The general color above is dark olive or black, with the margins of the shields of a paler shade. The margin of the under side of the carapace is black, with bright red markings; the plastron is yellow. Limbs, tail and neck, black, lined with red; head, lined with yellow. The shell of this species is flat and smooth; about five inches is the normal length.

Abundant in the vicinity of ponds, streams and marshes, these turtles may be often seen on floating logs or the like, from which they plunge quickly if alarmed. The food consists principally of small fishes and insects. Captive specimens thrive on raw chopped meat or fish.

Range: North America from New Brunswick to Georgia.

Local distribution: General and abundant.

Muhlenberg's Turtle, *Chelopus muhlenbergii* (Figs. 40 and 41), which somewhat resembles the Spotted Turtle (*Chelopus guttatus*),

Muhlenberg's Turtle.

may be easily distinguished from the latter species by the brilliant orange spot on each side of the head. The carapace is dark brown or black, sometimes marbled with light brown; the shields often show lighter margins. The shell is black beneath, blotched with yellow. The spot on each side of the head is quite characteristic. It is

FIG. 40. MUHLENBERG'S TURTLE

FIG. 41. MUHLENBERG'S TURTLE

FIG. 42. WOOD TURTLE

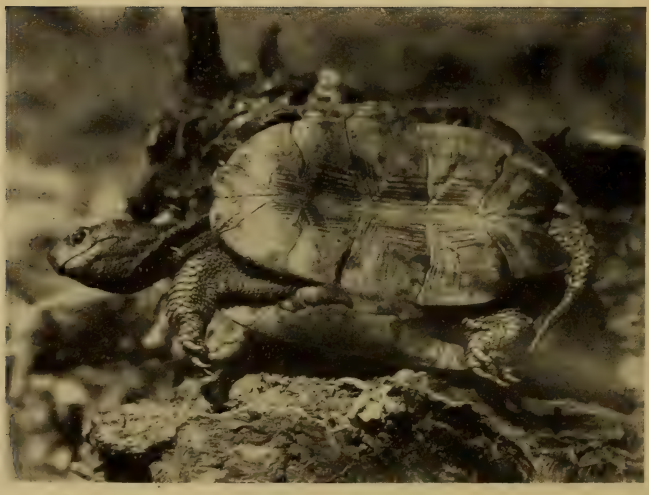

FIG. 43. WOOD TURTLE; ON ITS BACK

situated a little behind the eye and slightly above the region of the ear. The species is very rare in this vicinity. An adult specimen will measure four inches in length.

Range: Southern New York, New Jersey and eastern Pennsylvania.

Local distribution: Recorded from Staten Island and the Palisades of the Hudson River. Frequents shallow streams and swamps.

Wood Turtle.

The Wood Turtle, *Chelopus insculptus* (Figs. 42 and 43), sometimes called the Wood Tortoise, is a species quite terrestrial in habits. The general aspect of the carapace is rough, the plates being raised in concentric rings, and there is a distinct keel down the back. The color is brownish above, irregularly and rather indistinctly marked with yellow or light brown; the plastron is reddish yellow with a blotch of black on each plate; limbs, neck and fleshy parts tinged with salmon red. The head is uniform brown.

Although never found far from the vicinity of water, this species is not a water turtle, but prefers to roam about on swampy ground. In habits it resembles the Box Tortoise (*Cistudo carolina*), feeding largely upon vegetable matter. The Wood Turtle attains fairly large dimensions, the length of an adult specimen being eight inches.

Range: The northeastern United States.

Local distribution: General in swampy districts, but not common.

Spotted Turtle.

The Spotted Turtle, *Chelopus guttatus* (Fig. 44), rivals the Painted Turtle in being the most common of the local chelonians. The shell is smooth and black above with numerous round, yellow spots which vary in number on different individuals. The plastron is yellow, blotched with black. The average length of an adult specimen is four inches.

Range: Maine to South Carolina; westward to Ohio.

Local distribution: General and abundant.

The Box Tortoise, *Cistudo carolina* (Figs. 45, 46 and 47), is a strictly terrestrial species. The plastron is provided with a remarkable, practical double hinge, which is employed for pro-

FIG. 44. SPOTTED TURTLE

FIG. 45. BOX TORTOISE

tection in time of danger. When the reptile is annoyed, the front and rear sections of the plastron are pulled upwards towards the carapace, and so closely do the two shells come together that it is difficult to insert even a fine wisp of straw at any point between them.

Box Tortoise.

The Box Tortoise lives to great age, as is shown by the fact that specimens have been found upon the shells of which were names and dates that had been carved there sixty and seventy years before. Such tortoises were found near the fields in which

FIG. 46. BOX TORTOISE; ON ITS BACK

they lived when marked, hence the probability is that the animal is not a great traveler. During very dry seasons the Box Tortoise has been known to abandon the surface of the ground and burrow deeply into moist earth or mud.

Extremely variable in coloration, although the general colors are brown or black, irregularly marked with yellow, the species is more readily recognized by its form. The carapace is arched and high; the limbs are club-shaped and fitted for a terrestrial existence. Male specimens may be recognized by a distinct concave area on the rear section of the plastron and by their

red eyes. The Box Tortoise is largely herbivorous. It is very fond of berries. The length of an adult specimen is about six inches.

Range: The eastern United States.

Local distribution: General and common.

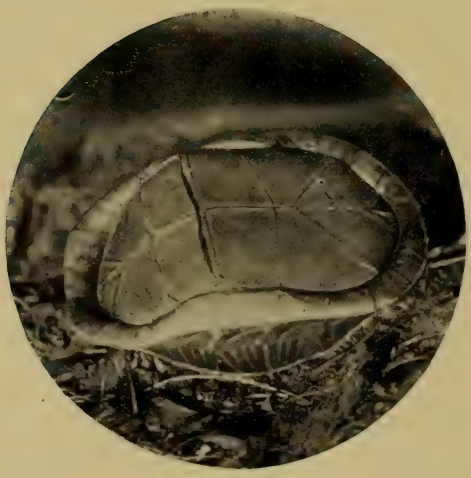

FIG. 47. BOX TORTOISE WITH CLOSED PLASTRON

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AMERICAN MUSEUM OF NATURAL HISTORY

The Batrachians of the Vicinity of New York City

By Raymond L. Ditmars

Curator of Reptiles, New York Zoölogical Park

With illustrations from photographs from life by Herbert Lang, American Museum of Natural History

REPRINTED FROM THE AMERICAN MUSEUM JOURNAL

VOL. V, No. 4, OCTOBER, 1905

Guide Leaflet No. 20

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FIG. 1. BULL FROG. NEARLY NATURAL SIZE
From specimen in New York Zoölogical Park

The Batrachians of the Vicinity of New York City

With Reference to the Collection in the American Museum of Natural History

By

RAYMOND L. DITMARS

CURATOR OF REPTILES, NEW YORK ZOÖLOGICAL PARK

With Illustrations from Photographs taken from Life

BY

HERBERT LANG

AMERICAN MUSEUM OF NATURAL HISTORY

GUIDE LEAFLET No. 20.

REPRINTED FROM THE AMERICAN MUSEUM JOURNAL,

VOLUME V, NO. 4, OCTOBER, 1905.

New York. Published by the Museum.

PREFATORY NOTE

The Museum gratefully acknowledges the coöperation of the New York Zoölogical Society in the preparation of the Guide. The author is Mr. Raymond L. Ditmars, Curator of Reptiles in the New York Zoölogical Park, Bronx Park, who also prepared the leaflet upon the local reptiles which was issued with the preceding number of the JOURNAL. Through Director W. T. Hornaday the abundant living material of the Zoölogical Park was placed at the disposition of the Museum for the purpose of making photographs for the illustrations, and through Director C. H. Townsend similar courtesies were extended at the New York Aquarium, Battery Park. The source of the illustrations is indicated under each figure.

CONTENTS

PAGE

Introduction . . . . . 161 [7]
Salamanders . . . . . 162 [8]
Key to the Salamanders . . . . . 163 [9]
Descriptive List of the Salamanders . . . . . 165 [11]
Marbled Salamander . . . . . 165 [11]
Spotted Salamander . . . . . 166 [12]
Tiger Salamander . . . . . 167 [13]
Four-Toed Salamander . . . . . 169 [15]
Gray Salamander . . . . . 170 [16]
Red-Backed Salamander . . . . . 171 [17]
Slimy Salamander . . . . . 172 [18]
Two-Lined or Yellow-Backed Salamander . . . . . 173 [19]
Long-Tailed, or Cave, Salamander . . . . . 174 [20]
Red Salamander . . . . . 176 [22]
Mountain Salamander . . . . . 177 [23]
Dusky Salamander . . . . . 178 [24]
Water Newt . . . . . 180 [26]
Red Eft, or Mountain "Lizard" . . . . . 181 [27]
Toads and Frogs . . . . . 184 [30]
Key to the Toads and Frogs . . . . . 185 [31]
Descriptive List of the Toads and Frogs:
Common Toad . . . . . 186 [32]
Spadefoot Toad . . . . . 190 [36]
Cricket Frog . . . . . 192 [38]
Swamp Tree Toad . . . . . 193 [39]
Pickering's Tree Toad . . . . . 194 [40]
Anderson's Tree Toad . . . . . 197 [43]
Gray Tree Toad . . . . . 197 [43]
Salt-Marsh Frog . . . . . 198 [44]
Leopard Frog, or Pickerel Frog . . . . . 200 [46]
Pond Frog, or Green Frog . . . . . 201 [47]
Bull Frog . . . . . 203 [49]
Wood Frog . . . . . 205 [51]

The collection illustrating the local batrachians may be found at present in the Synoptic Hall, No. 107 of the ground floor of the Museum Building.

THE BATRACHIANS OF THE VICINITY OF NEW YORK CITY.[1]

By Raymond L. Ditmars,

Curator of Reptiles, New York Zoölogical Park.

With Illustrations from Photographs Taken from Life

By Herbert Lang,

American Museum of Natural History.

Introduction.

FOLLOWING the reptiles in zoölogical classification come the batrachians, creatures which may be said to constitute a connecting link between the reptiles and the fishes. Unlike the former, the great majority of batrachians begin life as strictly aquatic, fish-like forms, provided with gills, which with many species are elaborately developed in the shape of external, fringed processes. From this aquatic form, with gills (the tadpole or larval stage), the average batrachian ultimately matures into a creature constituted to breathe atmospheric air.

Swamps and bogs and the borders of streams and ponds are usually the homes of the batrachians, which thrive in such damp situations. Some species, like the toad, are quite terrestrial, and many are subterraneous, but with few exceptions they frequent the immediate vicinity of water or damp and shaded places. There are species that remain aquatic throughout life, like the Mud Puppy (*Necturus*) and the Hellbender (*Cryptobranchus*), both North American species. In the Old World is found the *Proteus*, a blind and translucent species, that passes its entire existence in underground rivers or in the dark lakes of European caverns.

[1] Reprinted from *The American Museum Journal*, Vol. V, pp. 161–206, Oct., 1905.

With but few exceptions the mature batrachians differ from the reptiles in the total absence of scales. Their naked, usually slimy skin at once defines them to the novice. The few scaled species indicate their scalation only upon close examination, and beneath the shining skin may be discerned a fine dermal texture. No species among the local batrachians possesses scales.

In our local fauna, two orders of the Batrachia are represented. These are the *Urodela*, comprising Salamanders and Newts, and the *Salientia*, or Tailless Batrachians (the Toads and Frogs).

SALAMANDERS.

Order *Urodela*.

The salamanders and the newts may be easily recognized by their lizard-like form, but even the novice may at once distinguish them from true lizards by their moist or slimy, naked skin, totally devoid of scales. Many of the semi-aquatic species, however, are actually known in the regions they inhabit as water "lizards."

The majority of the local species begin life, like the frogs and toads, as tadpoles, hatching from opaque eggs which are deposited in streams and ponds. Unlike the frog larva however, the tadpole of the salamander retains throughout the larval state external gills, arranged in three tufts on each side of the head. These gills are delicately fringed and enable the young creature to lead a fish-like existence. The presence of these organs enables the observer to distinguish at a glance the larvæ of the salamanders and newts from those of the frogs and toads. Apart from the gills, however, the salamander tadpoles differ from the tailless batrachians in the development of the limbs. The front limbs are the first to appear, an external character quite reversed among the frog larvæ. Though the development with the latter is the same as with the salamanders, the growth of the front limbs goes on under cover of the operculum, while the hind limbs are attaining external development. When the front limbs attain their growth, they push their way suddenly through the folds of the operculum and into view.

A few of the local salamanders, represented by the genera

Plethodon and *Hemidactylium*, undergo their metamorphosis in damp places under stones or logs in the woods. The young of these possess branching gills when hatched, but the gills are absorbed within a few days.

In the vivarium, many of the salamanders may be kept for observation by providing them with some three inches of damp *Sphagnum* moss, over which have been placed strips of old bark. The moss should be kept very damp. Ant larvæ, the grubs of the smaller wood-boring beetles and small earthworms serve as food.

If these creatures were provided with scales like the reptiles, the making of a popular key for identification would be simple. There is, however, among most salamanders a peculiar uniformity of external surface and general structure. Technical divisions of the *Urodela* are founded upon the arrangement of the teeth, the anatomical structure of the tongue, the shape of the tail and the development of the toes. In the preparation of the following key, however, the writer has relied upon the few characters that appeal to an observer not versed in technical terms. The characters employed pertain to variation of *outline*, where such exists, *size* and *color-pattern*. In our local fauna four families, comprising twelve species and two varieties, are represented. These are, the AMBLYSTOMIDÆ, represented by *Amblystoma opacum*, *A. tigrinum*, *A. punctatum;* the PLETHODONTIDÆ, *Plethodon glutinosus*, *P. cinereus*, *P. cinereus erythronotus*, *Hemidactylium scutatum*, *Spelerpes ruber*, *S. bilineatus*, *S. longicauda;* the DESMOGNATHIDÆ, *Desmognathus fusca*, *D. ocrophæa;* the PLEURODELIDÆ, *Diemyctylus viridescens*, *D. viridescens miniatus*.

Key to the Salamanders.

a. FORM STOUT, SIZE LARGE.

1. *Tail flattened towards the tip.*

Black, marbled with grayish white blotches..... **Marbled Salamander** (*Amblystoma opacum*).

Black, marbled with yellow, the yellow predominating... **Tiger Salamander** (*Amblystoma tigrinum*).

Black, two rows of yellow spots, black predominating. **Spotted Salamander** (*Amblystoma punctatum*).

b. BODY CYLINDRICAL, ELONGATED.

1. *Tail rounded.*

Size moderate; black, with silvery spots..... **Slimy Salamander** (*Plethodon glutinosus*).

Size very small; brown, with minute white dots..... **Gray Salamander** (*Plethodon cinereus*).

Size very small; dark gray, a reddish band on back..... **Red-backed Salamander** (*Plethodon cinereus erythronotus*).

2. *Tail bluntly oval.*

Size small; snout very blunt; brown, paler on back..... **Four-toed Salamander** (*Hemidactylium scutatum*).

3. *Tail flattened towards the tip.*

Size moderate; bright red, spotted with black..... **Red Salamander** (*Spelerpes ruber*).

Size small; yellow band on back, dark bands on the sides..... **Two-lined Salamander** (*Spelerpes bilineatus*).

Size larger; yellow, sides with many black spots and a median dorsal series thereof; tail keeled above, very long. **Long-tailed, or Cave Salamander** (*Spelerpes longicauda*).

Size moderate; gray, minutely dotted with white; greater length of tail flat..... **Dusky Salamander** (*Desmognathus fusca*).

Size moderate; brown, lighter on head; basal half of tail rounded..... **Mountain Salamander** (*Desmognathus ocrophæa*).

c. OUTLINES WELL PROPORTIONED; SIZE SMALL.

1. *Tail flat from base to tip.*

Skin smooth; tail fin-like; olive above, yellow beneath, a row of red spots on side; aquatic..... **Water Newt** (*Diemyctylus viridescens*).

Skin rough; tail thicker; reddish brown to vermilion; terrestrial..... **Red Eft; Mountain "Lizard"** (*Diemyctylus viridescens miniatus*).

Descriptive List of the Salamanders.

FIG. 2. THE MARBLED SALAMANDER
From specimen in New York Aquarium

The Marbled Salamander, *Amblystoma opacum* Gravenhorst (Fig. 2), is of moderate size and stout form, with flattened tail, which is thick at the base. General color slaty-black, with large elongated spots or blotches of grayish-white on the back and head. Some of the spots run together, producing a marbled appearance, a character which occurs on the back of many specimens. The spots are regularly disposed as half-rings on the upper surface of the tail, producing a banded appearance. Beneath, this species is a uniform bluish-black. It may be distinguished from the other local representatives of the genus by its grayish-white markings, the other species possessing yellowish markings. Total length, $4\frac{3}{4}$ inches; length of tail, 2 inches.

Marbled Salamander.

Range: The eastern and central portions of North America.

Local Distribution: General in this vicinity, but not common.

The larvæ of the marbled Salamander may be found in shallow ponds in the openings of woods. They grow rapidly and leave the water late in June or early in July. While developing, they present a dull, grayish appearance, thickly dotted with white, which pattern gives way to the markings of the adult a short time prior to their leaving the water. In the adult form this salamander selects dry situations, and may be found under stones in sandy, or dry and hilly country, where it burrows to some depth.

FIG. 3. THE SPOTTED SALAMANDER
From specimen in New York Zoölogical Park

Spotted Salamander.

The Spotted Salamander, *Amblystoma punctatum* Linn. (Fig. 3), is a large form with stout body and broad head. The tail is rounded at the base, but bluntly compressed towards the end. Black above, with a row of round brilliant-yellow spots on each side. This row extends to the tip of the tail and is a ready means of identification. There are several of these spots, too, on the upper surface of each limb. The lower sides are slaty-gray, sprinkled with small, bluish-white spots. In form the Spotted Salamander slightly resembles the Tiger Salamander, but may be distinguished therefrom by the

regularity of its color pattern. Total length, $7\frac{1}{2}$ inches; length of tail, $3\frac{3}{4}$ inches; width of head, $\frac{3}{4}$ inch.

Range: Eastern and central North America.

Local Distribution: Sparing, in damp woods.

The eggs are deposited early in the spring in ponds and small streams. They resemble the spawn of frogs. The adult may be found under logs and stones in thinly timbered sections. Like the other species of this genus, this salamander will live for years in the vivarium.

FIG. 4. THE TIGER SALAMANDER
From specimen in New York Zoölogical Park

The Tiger Salamander, *Amblystoma tigrinum* Green (Fig. 4), is a large species with stout body, flat head and compressed tail. Ground color above, dark brown or gray (sometimes black), thickly covered with large, irregular, yellowish blotches. The blotches predominate and impart a marbled appearance to the animal. On the lower portions of the sides the yellow is present in the form of round spots, or scattered blotches, and the ground color is lighter. The chin is thickly marked with yellow, but little of the color is apparent on the abdomen, which is gray. The intensity of the markings depends much upon the age of the individual. Very old specimens show a faint pattern and in some lights appear to be of a dull, uniform

Tiger Salamander.

brown. This is the largest of our salamanders. Although in form resembling the Spotted Salamander, its blotched appearance makes identification easy. The limbs are large and well developed. A mature specimen from New Jersey shows a total length of $8\frac{1}{2}$ inches; the tail is $3\frac{3}{4}$ inches long, and the head $\frac{3}{4}$ inch wide. The species is said to attain a length of eleven inches.

Range: The entire United States and southern Canada; northern and central Mexico.

Local Distribution: Rare, but found occasionally on Long Island and in New Jersey.

Although one of the rarest of the local batrachians, the Tiger Salamander is our most interesting species. The metamorphosis from the larval to the adult form depends largely upon light and temperature, and is strongly influenced by surrounding conditions. In the western and southwestern portions of the United States it is abundant, and throughout those areas, for many years, its larval or tadpole stage was thought to constitute a distinct species, the Axolotl. In permanent lakes of some depth, where the water remains moderately cold and there is abundance of food suitable for the larval form, this creature evinces an interesting persistency in retaining the branching gills (branchiæ) and continues its aquatic existence for indefinite periods even attaing the size of the terrestrial form.

More remarkable, however, than tardy metamorphosis is the fact that during this evidently larval state these creatures breed and deposit eggs. In this aquatic form the species has had several different names. In the case of an evaporating pool, slowly drying away under the summer sun, the larva finds an opportunity along the shallow borders frequently to employ its nostrils at the surface of the water, with the result that the gills become degenerated and transformation is hastened.

Adult specimens secrete themselves in burrows, not far from the vicinity of water, although they may be occasionally found hiding under decaying logs, in very moist situations. They prey upon insects and worms, and they even attack larger creatures, when within reach. A specimen in the writer's collection devoured several very young field mice. Hiding by day, they prowl during the hours of darkness or during rains.

The Four-toed Salamander, *Hemidactylium scutatum* Tschudi (Fig. 5), is small, with cylindrical body and very bluntly oval tail. Color above, deep reddish brown; about the head, especially on the snout, there is a lighter shade, approaching bronze. Close examination of most specimens will reveal the presence of numerous dark spots on the upper surfaces. The sides of the body present a mottled ap-

Four-toed Salamander.

FIG. 5. THE FOUR-TOED SALAMANDER
From specimen in Am. Mus. Nat. Hist.

pearance, and the ground color is much lighter than on the back. The entire under surface is bluish-white, with a few, irregularly placed dark spots, presenting a strong contrast with the principal color.

This small species somewhat approaches the Gray Salamander in appearance, but may be distinguished therefrom by its very blunt snout and proportionately shorter tail. The back and the sides are strongly marked with furrows, a feature in which the species is quite unique. The limbs are small and weak. There are but four toes on the hind foot. Total length, 3 inches; length of tail, 1½ inches.

Range: The entire eastern portion of the United States.

Local Distribution: Mostly along the Palisades of the Hudson River.

The Four-toed Salamander, rather a rare species in this vicinity, is generally found in scattered companies. It is strictly terrestrial, and inhabits timbered regions, where it hides under logs and stones.

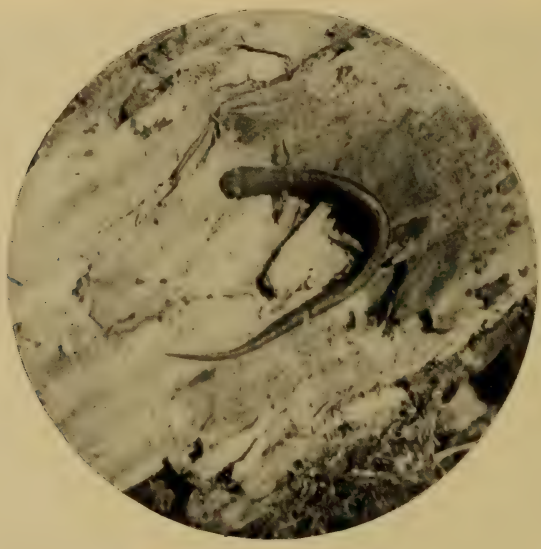

FIG. 6. THE GRAY SALAMANDER
From specimen in New York Zoölogical Park

The Gray Salamander, *Plethodon cinereus* Green (Fig. 6), is a small form, very slender and worm-like; tail round and long.

Gray Salamander.

Color above, dark brown, grayish or black, sprinkled with minute silvery spots. Sides of the body lighter and speckled with dark gray. Abdomen pale gray, marbled with a darker shade. Total length, 3 inches. Diameter of body, $\frac{3}{16}$ of an inch.

Range: Southern Canada and the United States generally, east of the Mississippi.

Local Distribution: Particularly abundant on the Palisades of the Hudson River.

This very common little salamander is strictly terrestrial.

It may be found in numbers, hiding under flat stones and logs in damp woods. Although provided with very small and slender limbs, it displays remarkable agility when disturbed, either wriggling its way among fallen leaves, or progressing over them by a series of jumps caused by doubling its worm-like body into a series of lateral undulations and suddenly straightening itself.

The eggs are deposited under damp and decaying logs, in moss or under stones. When the minute larvæ emerge, they possess external gills, but these are absorbed within a few days'

FIG. 7. THE RED-BACKED SALAMANDER
From specimen in New York Zoölogical Park

time. The species is never aquatic at any stage of its life. It is easily distinguished from the other salamanders by its extremely slender body and perfectly round tail.

The Red-backed Salamander *Plethodon cinereus erythronotus* Green (Fig. 7), in size and dimensions is like the preceding form. Grayish on the sides with a bright reddish band on the back. **Red-backed Salamander.**

This band is wide, covering the greater portion of the back and extending towards the end of the tail, where it becomes obscure. The lower portions of the sides present a

thickly dotted appearance; the abdomen is grayish, marbled with darker gray. On some specimens the bright band on the back is sprinkled with small gray dots, but these are so minute that they scarcely produce a dull effect upon the color. On occasional specimens these dots fuse together, forming a dull line down the back, and imparting a resemblance to the markings of many specimens of the Two-lined Salamander. From the latter, however, the present species is at once distinguished by its round tail.

Range: The United States east of the Mississippi and southern Canada.

FIG. 8. THE SLIMY SALAMANDER
From specimen in New York Aquarium

Local Distribution: Generally abundant in damp woods.

This variety is commonly found with the typical form, and occasionally under the same logs and stones with the Slimy Salamander.

Slimy Salamander.

The Slimy Salamander, *Plethodon glutinosus* Green (Fig. 8), is of moderate size and rather slender, cylindrical form. The tail is round. Black above, thickly covered with irregular greenish-white, or lichen-gray spots, these often appearing like patches of silvery dust. Different specimens show great variation in the size of the patches, some being blotched with the light color, while others might be said to

be finely speckled therewith. Lead color beneath, on which dull surface many specimens show numerous white dots. This species somewhat resembles the Marbled Salamander, but may be distinguished therefrom by its round tail and more numerous spots. It is, moreover, a more slender creature. The neck is much narrower than the head, causing the latter to look broad and flat, as in the larger salamanders (*Amblystoma*). Total length, 5 inches; length of tail, 2½ inches.

Range: From Canada to Florida and westward to Texas.

Local Distribution: General and common. It is particularly abundant on the New Jersey side of the Hudson River, along the Palisades.

When handled, this salamander exudes through the skin a whitish mucus that adheres persistently, hence the technical name, *glutinosus*, and the common one, Slimy Salamander. It is a common species, preferring hilly or mountainous districts, where it leads an entirely terrestrial life, hiding under stones and logs in thickly timbered places, whence it issues at night or in rainy weather.

Two-lined, or Yellow-backed, Salamander.

The Two-lined, or Yellow-backed, Salamander, *Spelerpes bilineatus* Green (Fig. 9), is a small, slender form, with flat tail. Yellowish on the back, which color is bordered on each side with a band of dark gray, brown or black. These bands start from behind the eye and extend down the tail. Beneath the bands the color is pale yellow, profusely sprinkled with dark spots. The broad, yellowish band, covering the back is often spotted with dark gray or brown, and on some specimens the spots run together down the back forming a narrow, dark line. The entire under surface is bright and immaculate yellow. The body is cylindrical; the tail decidedly compressed. Total length, 3⅜ inches; length of tail, 1⅞ inches; diameter of body, ¼ inch.

Distribution: General, very abundant in the beds of rocky brooks.

Range: From Maine to Florida, and westward to the Missouri River.

The Two-lined Salamander is an extremely active species. It

is usually found hiding under flat stones in the beds of brooks, not actually under water, but where the soil is thoroughly saturated with moisture. When disturbed in its hiding-places, it does not entirely depend upon its diminutive limbs for escaping from danger, but makes surprisingly rapid progress by doubling its body into a series of lateral undulations and suddenly straightening it. The result is a number of bewildering jumps. This performance is varied with a snake-like wriggling. Thus, with a combination of agile motions, the little animal makes like a flash

FIG. 9. THE TWO-LINED OR YELLOW-BACKED SALAMANDER
From specimen in New York Zoölogical Park

for the water and secretes itself among the stones. It is seldom seen except in the immediate vicinity of water, and the larvæ attain nearly the size of the adult before they begin an air-breathing existence.

Long-tailed, or Cave, Salamander.

The Long-tailed, or Cave, Salamander, *Spelerpes longicauda* Green (Fig. 10), resembles in form the Two-lined Salamander, but is a larger species and has a proportionately longer tail. The tail is much compressed and considerably longer than the body. The back is rich yellow, the sides paler. Scattered over the entire upper surface are coarse, black dots, which, on the sides of the tail

usually fuse into a series of upright bands. The abdomen is immaculate yellow. Total length, $4\frac{3}{4}$ inches; length of tail, $2\frac{7}{8}$ inches.

Range: The Central States, and inland portions of the Atlantic States.

Local Distribution: Mr. W. D. W. Miller has captured specimens near Plainfield, New Jersey. The writer has not taken it within the limits embraced by this work, but has found it abundant in Pennsylvania.

FIG. 10. THE LONG-TAILED, OR CAVE, SALAMANDER
From specimen in Am. Mus. Nat. Hist.

This vividly marked species is at times found at a considerable distance from water, though always in damp situations—in caves or among the fissures of moss-covered rocks. The writer took large numbers of specimens along a mountain stream, at the Delaware Water Gap, Pennsylvania. They were hiding under flat stones in the bed of a nearly dry stream. Their rich coloration was in strong contrast to the damp sand. About a dozen of these specimens lived for a period of more than two years in damp, *sphagnum* moss, placed in an vivarium. During

this period they were supplied with ant-larvæ and white ants, or termites. During the day they always remained hidden, but at night they were frequently observed crawling about the surface of the moss.

Red Salamander.

The Red Salamander, *Spelerpes ruber* Daudin (Fig. 11), is of moderate size. Its form is cylindrical, — slender when young, becoming stout with an increase in length. Limbs small; tail rounded at base and becoming flattened towards the tip. Rich red or salmon color above, profusely sprinkled with small black spots; paler beneath.

FIG. 11. THE RED SALAMANDER
From specimen in New York Zoölogical Park

Young specimens are frequently of a bright coral-red and not distinctly spotted. Those of medium size are darker red, with intensely black spots, while old specimens are often brownish and spotted with gray. Total length of fully adult specimen, $5\frac{1}{2}$ inches; length of tail, $2\frac{1}{2}$ inches; diameter of body, $\frac{1}{2}$ inch.

Range: Canada to the Gulf of Mexico and westward to the Mississippi River.

Local Distribution: Moderately abundant in the Orange Mountains of New Jersey.

The eggs are deposited early in the spring in the deeper pools of brooks; the adults are semi-aquatic, living in the beds of clear and cold brooks under flat stones or in immediate proximity to the water, into which they quickly make their way when disturbed. They may be sometimes found hiding under the luxuriant moss that covers rocks adjacent to mountain streams, where their brilliant color is in vivid contrast to their surroundings.

FIG. 12. THE MOUNTAIN SALAMANDER
From specimen in New York Zoölogical Park

The Mountain Salamander, *Desmognathus ocrophæa* Cope (Fig. 12), is of moderate size. Body cylindrical; tail rounded for the greater part of its length, flattened near the tip and tapering to a long, sharp point. A wide band of brown extends down the back from behind the head to the base of the tail, where it narrows and becomes indistinct towards the tip. Beneath the brown band the sides are dark gray. From the eye to the angle of the mouth there is a band of light color. The abdomen is dirty white, and generally sprinkled with pure white dots.

Mountain Salamander.

On occasional specimens the back is sprinkled with a line of black dots, giving the species a very similar pattern to the Two-

lined Salamander, which it also resembles in outlines. The adult Mountain Salamander may be recognized, however, by its rounded tail. Young specimens strongly resemble the Red-backed Salamander, even to the rounded tail. The following characters should be considered in separating them:

Desmognathus ocrophæa.[1]	*Plethodon cinereus erythronotus.*
Form moderately slender.	Form very slender.
Stripe down the back brownish.	Stripe down the back reddish.
A light band from eye to angle of mouth.	No band from eye to angle of mouth.

Total length, $3\frac{1}{2}$ inches; length of tail, $1\frac{5}{8}$ inches; diameter of body, $\frac{5}{16}$ inch.

Range: Common in the Adirondacks and the mountains of northern Pennsylvania, whence it extends southward into the mountain chains of Virginia and North Carolina.

Local Distribution: Very rare, and the species may possibly not occur within the limits given. A single specimen has been taken at Greenwood Lake, N. J.[2] It has also been found in Allegany County, N. Y. It may occur in the Orange Mountains of New Jersey.

In habits it appears to be quite terrestrial, living under decaying logs or burrowing its way under their bark.

Dusky Salamander.

The Dusky Salamander, *Desmognathus fusca* Rafinesque (Fig. 13), is of medium size. The body is cylindrical and moderately slender; tail flat. Color above dark brown or gray, with an obscure, reddish brown tinge on the back. The reddish brown tone is usually distinct on the tail, where it is paler in hue. Numerous black spots show through the brown of the back, which is often bordered with a tinge approaching pink or flesh color, the pink also showing on the tail. Outside this pinkish shade are numerous minute white dots arranged in thick clusters on the sides of the body. The skin of the abdomen is light and translucent and finely marbled with gray. Very old specimens are generally so dark as to

[1] This species is of doubtful or very rare occurrence in this vicinity.

[2] Taken by Eugene Smith, of Hoboken, N. J.

appear almost uniform black above and show no traces of markings except on the sides and abdomen. The head is about the same width as the body. The front pair of limbs is feeble; the hind pair, larger and stronger. Total length, $4\frac{3}{4}$ inches; length of tail, $2\frac{1}{4}$ inches; diameter of body, $\frac{3}{8}$ inch.

Range: Eastern North America.

Local Distribution: Abundant in the vicinity of small streams. This is the most abundant of our salamanders, but it is not

FIG. 13. THE DUSKY SALAMANDER
From specimen in New York Zoölogical Park

found except in the immediate vicinity of water. It is common in all situations where flat stones, dead leaves or similar objects not actually in the water, but in damp or muddy places in the beds of pools, offer concealment. When discovered in its lairs it runs and wriggles with bewildering agility, often taking to shallow water and secreting itself in the mud in order to escape. According to Cope, the eggs of this species are connected by an albuminous thread, which contracts and hardens after deposition. One of the sexes protects this string of eggs by twisting it about the body and remaining in concealment. The exact duration of the guard over the progeny is not definitely known. The young

salamanders emerge from the eggs with traces of external gills, which are soon absorbed.

Water Newt.

The Water Newt, *Diemyctylus viridescens* Rafinesque (Fig. 14), is of medium size. The body is rather stout; the tail very flat and fin-like. Dark olive or green above, on which are scattered numerous small black dots; on each side of the back is a row of small round spots of brilliant vermilion or brick red and bordered with narrow rings of black. The abdomen and lower sides of the body are pale yellow, which

FIG. 14. THE WATER NEWT
From specimen in Am. Mus. Nat. Hist.

meets in abrupt contrast the olive of the upper surface; this pale color is thickly covered with small black dots. On the head the line of meeting of the dark and light colors is slightly below the center of the eye.

The tail is very thin and at all times shows traces of fin-like edges, this character being particularly noticeable with the males during the autumn and the spring. Compared with the size of the body the limbs are large and well developed. Male specimens may be distinguished from the females by the large and stocky appearance of the hind limb, the lower joint of which is flattened and very wide, and in appearance quite out of

proportion to the front limb. In female specimens the front and hind limbs are of nearly equal size. During the autumn the males acquire a peculiar series of hard ridges along the inner surface of the hind limbs. This growth is more pronounced during the breeding season when it is clearly discernible as a raised, black process of skin, with a rough surface like the angular edge of a file. Total length, $3\frac{7}{8}$ inches; length of tail, $2\frac{1}{4}$ inches.

Range: Eastern United States and southern Canada.

Local Distribution: General, in ponds and lakes.

In this immediate vicinity, the Water Newt is a strictly aquatic creature, unless, on account of unusual summer heat, the waters of its pond evaporate, when it takes shelter under stones or pieces of bark and in such damp places awaits the refilling of its pond by the fall rains.

The species breeds in the early spring, depositing the eggs singly or in pairs. The eggs are covered with a glutinous envelope and are deposited in such a manner that they adhere to the leaves of aquatic plants. The larvæ possess branching gills like those of the larvæ of the true salamanders. These gills often persist until the animals have reached a length of three inches or more, although absorption usually occurs when the larva is about two inches in length. Thus the transformation appears to be irregular, and not infrequently perfectly developed Water Newts are found that are barely one and one-half inches in length. The metamorphosis is undoubtedly hastened by the warmth of shallow ponds. After the gills have disappeared, the matured individual continues to lead an aquatic life, although if forcibly removed from the water and kept in a damp place, it will live for an indefinite time, breathing with a rapid trembling of the throat, which is the same as the respiratory gulping of the frogs.

Red Eft, or Mountain "Lizard."

The Red Eft, or Mountain "Lizard," *Diemyctylus viridescens miniatus* Raf. (Fig. 15), is a Water Newt which has deserted the ponds in mountainous districts and has taken up life in the damp woods. It is not, however, a distinct variety, since its terrestrial existence is irregular, and it frequently returns to the water to lead an aquatic life. The Red

Eft is merely a phase of the common Newt, but it is an interesting case of adaptation to environment.

Few observers who have visited mountainous places in the eastern United States have failed to notice in the damp woods the brilliant red "lizards" slowly making their way over the carpet of fallen leaves. Among residents of the country places they are known as Red Efts, Fire "Lizards" and Rain "Lizards." These are not lizards, but they are batrachians, and they represent a form of the common Newt that has seemingly tired of the water and begun a terrestrial existence. The animals vary in color from dull brown to brilliant vermilion. Rows of red dots

FIG. 15. THE RED EFT, OR MOUNTAIN "LIZARD"
From specimen in New York Zoölogical Park

are very apparent on the brown forms, while on the vermilion forms they are less distinct, but can be discerned as richer red, bordered with narrow circles of black. The brown specimens are forms that have left the water but a short time; those of the brilliant red hues have for some time been leading a terrestrial life. During dry weather the Red Efts hide under leaves and moss; after the summer showers they issue from their hiding-places to swarm through the woods.

In mountain ponds in the heart of districts where the red form is very abundant, the aquatic adults may be found swarming in the water. If the latter are taken from the water and kept in damp moss or among leaves, they lose their greenish tints and the smooth appearance of the skin, becoming dull brown and

rough, an indication of the red hue and rough skin of the terrestrial form. If, on the other hand, specimens found in the woods be placed in an aquarium, they at first show signs of marked distaste for their new quarters. After a time, however, they become reconciled to the water and lose their bright tints, thus beginning to assume the colors of their aquatic associates, while the tail grows broader and better suited for swimming. Very small, bright red forms are often found in the woods, demonstrating that such specimens have left the water immediately after completing the larval stage.

As an explanation of the eccentricities of this species it may be explained that the cool depths of the mountain forests, continuously and heavily shaded, and well saturated with moisture, offer the species an inducement to vary its life history. Close to New York City, where the red form is unknown, the writer has observed an intimation of this terrestrial tendency. In the thick woods of the Palisades of the Hudson, he has found occasional Newts hiding under pieces of bark that rested a few feet from the edge of a pool inhabited by numbers of the kind. Such specimens showed a tinge of brown like the form *miniatus*.

The terrestrial form has been described as possessing a much rougher skin and lacking the fin-folds of the tail of the aquatic form. These characters, however, are caused merely by the drying of the skin.

In the aquarium, the water form is an interesting creature, and may be kept in flourishing condition by feeding it small earthworms or small pieces of raw beef. The red form lives well in a vivarium which has been plentifully supplied with damp moss. It will eat the larvæ of ants and small earthworms. It may be found in the Highlands of the Hudson River. Its range of distribution is much the same as the water form, except that it occurs principally in mountainous districts.

TOADS AND FROGS.

Order *Salientia.*

The Toads and Frogs are the most familiar forms of the batrachians. Eleven species occur in the local fauna, representing four families. All of the local species deposit their eggs in the water and the young pass through a tadpole stage before acquiring the form of the adult. The duration of this larval stage varies considerably with the different species. In some it is limited to a few weeks, others require considerably more than a year to complete their metamorphosis. The growth in the water is much influenced by light and temperature.

For a short time after hatching, the tadpoles of most species are provided on the under surface of the head with two suckers. These organs enable the fragile creatures to cling to the leaves of aquatic plants instead of lying upon the muddy bottom, where they would be exposed to the attacks of many enemies in the shape of the carnivorous larvæ of aquatic insects. At the time of hatching, the young creatures are leech-like in appearance. Development is rapid. Within three days they present the complete form of the tadpole, with fin-like tail. Within a few hours after hatching the mouth-parts begin to develop, and a few days later the little creature feeds upon delicate aquatic vegetation. They then swim readily in search of food, and the suckers become aborted and quickly disappear.

For a few hours after leaving the egg, the frog tadpole possesses branching gills. These soon shrivel and their bases are covered with folds of skin (the "operculum"). Under this fold the fore limbs soon begin their growth. This is the first pair of limbs to acquire full growth, but they are not visible until after the hind pair has appeared. From external appearances the frog tadpole thus seems to acquire the posterior pair of limbs first. Somewhat later the front pair suddenly are thrust through the

folds of the operculum. This is in contrast with the larvæ of the salamanders, in which the operculum is absent and the fore limbs are nearly full grown before the rear pair is visible. Moreover, the tadpoles of the salamanders retain their gill-stalks on each side of the head until after the growth of the limbs is completed.

A popular key to the identification and classification of the Toads and Frogs follows:

Key to the Toads and Frogs.

I. Tips of toes (digits) expanded in the form of adhesive disks or "suckers"..... **The Tree Toads.**

a. SIZE VERY SMALL.

1. *Disks but slightly developed.*

Brown; a wide green band on the back..... **Cricket Frog** (*Acris gryllus crepitans*).

Gray; three brown bands on the back..... **Swamp Tree Toad** (*Chorophilus triseriatus*).

2. *Disks well developed.*

Brown to green (varying); a dark, X-shaped mark on the back..... **Pickering's Tree Toad** (*Hyla pickeringi*).

b. SIZE SMALL.

Bright green above, which hue is bordered on sides with a band of white. A purplish band from behind nostril.... **Anderson's Tree Toad** (*Hyla andersoni*).

Grayish, with wavy, irregular markings..... **Gray Tree Toad** (*Hyla versicolor*).

II. No digital disks. Size moderate to large..... **The Toads and Frogs.**

a. SIZE MODERATE.

1. Skin thickly studded with wart-like tubercles; a large gland behind the eye..... **The Toads.**

Pupil of eye horizontal..... **Common Toad** (*Bufo lentiginosus americanus*).

Pupil vertical..... **Spade-foot Toad** (*Scaphiopus holbrooki*).

2. Skin smooth; no gland behind eye ..... **The Frogs.**

2a. A vein-like fold of skin from behind eye to the groin.

Pale brown; a dark-brown blotch behind the eye ..... **Wood Frog** (*Rana sylvatica*).

Olive, with large, round, black spots, irregularly scattered... **Salt-marsh Frog** (*Rana virescens*).

Pale brown, with four rows of large black spots ..... **Leopard Frog** (*Rana palustris*).

Green or olive; head paler..... **Pond Frog** (*Rana clamitans*).

2b. No vein-like fold of skin.

b. Size large.

Olive, irregularly mottled with brown ..... **Bull Frog** (*Rana catesbiana*).

Descriptive List of the Toads and Frogs.

Common Toad.

The Common Toad, *Bufo lentiginosus americanus* Le Conte (Fig. 16), is of moderate size and stout form. The skin is very rough. A large and prominent gland exists behind the eye. Color above brownish or yellowish brown, with numerous large dark spots, narrowly, though distinctly, edged with pale yellow. Extending down the center of the back is a pale yellowish or whitish band. The abdomen is dirty white. The ground color varies in individuals, some being distinctly reddish, and is influenced by temperature and changes on the individual itself from a lighter to a darker shade or the reverse. The pupil of the eye is horizontal.

The Toad is a familiar creature and is quite characteristic in appearance on account of its very rough glandular skin and the large, swollen glands behind the eyes. The hind feet are but slightly webbed. The blackish hue of the skin under the throat of the male Toad distinguishes it from the female. This skin is capable of great extension as the creature gives voice to the peculiar cry of the breeding season. The females are larger than the males. Length of body of male specimen, $2\frac{3}{8}$ inches; of female, $2\frac{3}{4}$ inches.

Range: Four varieties of this species inhabit North America. One of these appears to occur only in northeastern Massachusetts; another is confined to the Rocky Mountain region; the typical form is found in the southeastern United States, while the variety that occurs locally is distributed over an extensive area, namely: from British America to the Southern States and westward to Arizona.

Local Distribution: Common and abundant.

There is but one species of the local batrachians which

FIG. 16. THE COMMON TOAD
From specimen in Am. Mus. Nat. Hist.

might be confused by the observer with the Common Toad, and that is the Spadefoot Toad. The Spadefoot Toad receives its name from a pronounced spade-like process on the inner edge of the hind foot, a feature which is also slightly developed on the common species. The color of the Spadefoot is, however, quite different from the ordinary toad. Instead of the single light band along the back of the Common Toad, the Spadefoot has two pale bands, which run together and fork at the end of the body.

Many of the reptiles and batrachians have habits which render them of considerable economic value to the agriculturist,

but the Toad ranks first in the list of useful species. Although mainly insectivorous, the depredation on insect life made by the frogs is chiefly confined to the borders of ponds and streams, or to the marshes; in fact, to places not available for agriculture. The Toad, on the contrary, is a terrestrial species, inhabiting the open country and abounding over stretches of farmland. Here at twilight multitudes of toads issue forth to prey upon all forms of insect life, continuing the hunt throughout the night, and retiring at dawn for digestion. The examination of a toad's stomach after a nocturnal excursion will reveal an amazing number of insect forms, among which may always be found species that are destructive to agricultural products.

Among the writings of Shakespeare there are allusions to the venomous character of the Toad which have inspired innumerable scientists to clash in argument. Comparatively recent anatomical investigations have resulted in the discovery that a milky secretion contained in the swollen glands situated behind the eyes and in minute glands scattered over the surface of the skin possesses decidedly poisonous properties. When this fluid is injected into the blood of small mammals, marked symptoms at once develop and speedy death follows. The symptoms produced have been described as similar to those due to the use of *digitalis*, the action being upon the nerve centers and the heart. The effect upon any unwary dog that seizes a toad in its jaws is at once evident. There are immediate signs of distress, and the animal soon foams at the mouth and champs its jaws as if in considerable pain. These symptoms continue for an hour or more.

When the larger glands on the head are compressed, tiny jets of a sticky white fluid are ejected to a distance of three or four inches. Through accident the writer has discovered that this fluid is intensely bitter to the taste. In spite of this poisonous secretion, the Toad is generally harmless when handled. The story of wart-producing powers, furthermore, is purely fallacious. The secretion in the glands which have been mentioned is dangerous only when injected directly into the blood of small animals, but nevertheless Shakespeare's much-combated references have been proved to have abundant foundation in fact.

Most batrachians, particularly those species with a rough skin, secrete a certain amount of this irritant.[1]

The Toad is protected by the characters just mentioned from attack by most mammals and birds. The species of snakes, however, that prey upon cold-blooded creatures, appear to prefer toads to frogs.

In its metamorphosis the Toad differs somewhat from the frogs. It leaves its place of hibernation rather late, not until warm weather has become established in the spring, when the weird, drawn-out trill of the males is heard about rain pools and shallow bodies of still water. The eggs are deposited in long strings.[2] After the strings have absorbed the required amount of water through their transparent covering and lie upon the bottom undergoing development. Each egg measures about a quarter of an inch in diameter. The tadpoles emerge from the eggs after a period of eight to ten days from deposition. They resemble minute leeches and cling for some hours to the leaves of aquatic plants by means of small suckers on the lower surface of the head. Within forty-eight hours they cease the clinging stage and wriggle their way about by means of a rapidly developing, fin-like tail. Four days after hatching they are agile swimmers and feed upon mossy growths of the pool.

The writer has made the following observations upon growth during the tadpole stage:

May	3.	Tadpoles hatched. Clinging stage.....	Length,	$\frac{1}{8}$ inch
"	4.	Body more elongate; swimming feebly at frequent intervals.....	"	$\frac{3}{16}$ "
"	5.	Tail distinctly compressed.....	"	$\frac{1}{4}$ "
"	6.	Tail shows fin-like edges.....	"	$\frac{9}{32}$ "
"	7.	Tail fully developed; feeding.....	"	$\frac{5}{16}$ "
"	12.	Body assuming stout proportions.....	"	$\frac{1}{2}$ "
"	17.	Color above jet black.....	"	$\frac{3}{4}$ "
"	25.	Tadpoles appear fully grown and cluster in masses in very shallow places.....	"	$1\frac{1}{16}$ inches

[1] Among the local frogs the character named is strongly evidenced by the Leopard Frog (*Rana palustris*). When handled, this species gives out a strong odor. Few snakes will eat it.

[2] The eggs of the frogs are deposited in masses.

May 26. Rudiments of hind limbs discernible.
" 30. Hind limbs perfectly formed in miniature and measure $\frac{3}{16}$ inch in length. The tadpoles are now brownish and show traces of spots..... Length $1\frac{5}{32}$ inches
June 4. Hind limbs $\frac{3}{8}$ inch long.
" 5. " " $\frac{7}{16}$ " "
" 12. " " fully developed..... " $1\frac{1}{4}$ "
" 14. Front limbs break through operculum.
" 16. Absorption of tail rapidly taking place.
" 18. Tail nearly absorbed; young toads leaving the water.
" 20. Metamorphosis complete; surrounding meadows teeming with perfectly developed toads measuring $\frac{7}{16}$ inch (body).

The full-grown tadpole of the Toad and the perfectly developed creature as it leaves the water, are much smaller than the frog tadpole, which usually attains a length of three and one quarter inches before growth of the hind limbs begins, while the perfect frog generally measures an inch or more when it becomes fitted for semi-aquatic life. The tiny toads fall a prey to many enemies, and but a small proportion of their numbers attains maturity. Full growth is reached in about three years.

Spadefoot Toad.

The Spadefoot Toad, *Scaphiopus holbrooki* Harlan (Fig. 17), is moderate in size. In form it is very stout, with wide, blunt head. Color, dark brown, or ashy-brown, with two rather indistinct bands of paler shade on the back; these bands begin behind the eyes and extend in wavy or irregular fashion to the end of the body, where they run together.

Although the skin is rough and is covered with numerous raised points, it presents a smoother surface than that of the Common Toad. The parotid gland (behind the eye), though well-developed and very pronounced, is of smaller size in proportion to the individual than that of the Common Toad.

On the inner portion of the under surface of the hind foot there is a hard, spade-like process, tinged at the edge with deep black. From this appendage the creature derives its name. The hind foot is fully webbed. The pupil of the eye is elliptical

(cat-like), a characteristic which is useful in distinguishing this species from the Common Toad, since in the latter the pupil is horizontal.

The species presents some variation in color pattern. Specimens from the northern portions of the United States are sometimes nearly uniform in color, while those from the extreme South possess a very distinct pattern. Length of body, in sitting posture, 2½ inches; total length, hind limbs outstretched, 5 inches; width of head over ear plates 1⅛ inches.

Range: The entire eastern United States, from New England to Florida and westward to Texas.

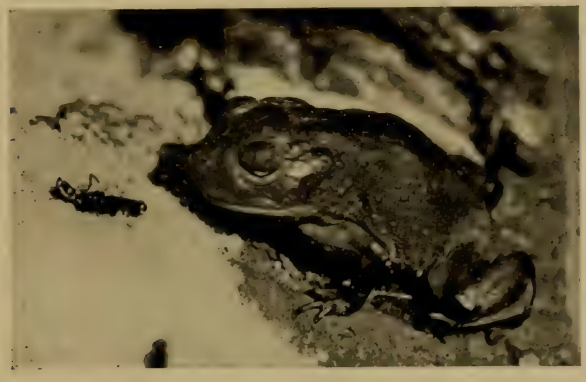

FIG. 17. THE SPADEFOOT TOAD
From specimen in New York Zoölogical Park

Local Distribution: Rare.

The retiring habits of the Spadefoot Toad render it an object seldom seen. The animal employs the sharp scoops of its hind feet to work its way into the soft ground or sand, and there passes the hours of daylight entirely hidden. At night or after heavy showers it ventures abroad for food, sometimes lingering in the vicinity of a rain-pool and uttering its plaintive cry. During the latter part of April and in May this toad congregates in numbers about shallow bodies of water to breed. The voice of the male resembles the tremulous call of the Common Toad, but is slightly louder. The eggs are similar to those of the Toad, and are laid in strings. The metamorphosis is completed within a few weeks from the time of hatching.

The Cricket Frog, *Acris gryllus crepitans* Baird (Fig. 18), is very small. The skin is rough. The body color is brown or grayish brown. Extending from the snout nearly to the end of the body there is a wide band of bright green, which is interrupted between the eyes by a dark triangular blotch, with its point directed backwards. There are three small blotches on the sides, while the hind limbs are banded with dark brown. Beneath, the color is yellowish white.

Cricket Frog.

This species is subject to rapid and marked color changes

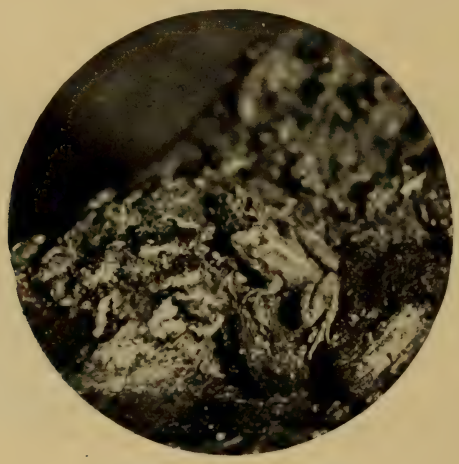

FIG. 18. THE CRICKET FROG
From specimen in New York Zoölogical Park

under the influence of varying temperature and the mood of the individual. These changes affect the general color of the body and the bright band down the back. The band, although usually of some shade of green, sometimes fades to yellowish brown. The species is easily distinguished on account of its distinct color pattern. It is the smallest of the local, tailless batrachians. Length of body, $\frac{7}{8}$ inch; total length with hind limbs outstretched, $2\frac{1}{4}$ inches.

Range: The typical form occurs from North Carolina to Florida, and westward to Louisiana. The variety *crepitans*, also, is found from the southern portion of New York State to North Carolina; it extends westward to Kansas, and still farther westward in the extreme northern portion of its range.

Local Distribution: The local form, var. *crepitans*, is common in portions of Long Island and in New Jersey.

The Cricket Frog frequents the borders of shallow pools, where its sharp, trilling cry, resembling in volume the call of the field cricket, may be heard at various times of the year. It is particularly vociferous during the breeding season. The eggs are deposited early in May in small bunches. They usually adhere to grass or reeds.

The animal is very difficult to capture, since it possesses

FIG. 19. SWAMP TREE TOAD
From specimen in Am. Mus. Nat. Hist.

great leaping powers and quickness in diving. During periods of heavy dew these frogs may be found in high grass adjacent to marshes. Owing to its smallness and agility, it is rarely observed after the breeding season.

Swamp Tree Toad.

The Swamp Tree Toad, *Chorophilus triseriatus* Wied. (Fig. 19), although a very small species, is larger than the Cricket Frog. It may be readily recognized by the coloration. The ground color is pale gray. On the back are three dark brown stripes or bands, extending the length of the body. On the side is a broader band, extending from the snout

across the eye and thence along the greater length of the body. The abdomen is whitish, with a few scattered black dots. Length of body, $1\frac{1}{16}$ inches; total length, with hind limbs outstretched, $2\frac{1}{4}$ inches.

Range: This is essentially a western species. It is very abundant in the northwestern portion of the United States, east of the Rocky Mountains, whence it extends southward into Texas. The range extends eastward in the shape of a narrowing band which terminates in central and southern New Jersey. In this apex of its eastern distribution the species is common, especially in the swampy areas of the barrens of the southwestern part of the State.

Local Distribution: Mr. W. D. W. Miller has taken many specimens near Plainfield, N. J.

Like other species of the *Hylidæ*, this creature leaves its winter quarters early and gathers about shallow pools and ditches to breed. It is not an agile swimmer, since the hind feet are not webbed. If alarmed when near the water, it wriggles its way into the marginal vegetation so quickly that it is difficult to capture. Its cry is a sharp trill like that of the Cricket Frog.

Pickering's Tree Toad.

Pickering's Tree Toad, or "Peeper," *Hyla pickeringi* Storer (Fig. 20), is a very small animal. The body is pale brown above with distinct, narrow markings on the back which assume the form of an X on the upper portion of the back, behind which is a ∧-shaped marking. At the end of the body there is another mark, similar to the latter, but of about half the size. A similar mark with the point directed backwards occurs behind the eyes. A band of the same dark color that constitutes the markings on the back extends from the snout across the eye, and thence down the side to a short distance behind the fore limb. The hind limbs are banded. Beneath, the color is yellowish white.

Although the color-pattern is generally pronounced, and the usual colors of the species are as described, this individual varies greatly in color, not only in different individuals but also in the same individual at different times. The writer has observed specimens of normal colors change to pale gray, and

others to a bright tint of green. While the animal was in the green phase, the pattern on the back could not be discerned.

The toes are provided with well-developed adhesive disks, or "suckers," which are particularly distinct on the fore feet. The skin of the abdomen is coarse and granulated; that of the back is smooth.

Male specimens of this species may be distinguished from the females by the loose, dark skin on the throat. This loose skin constitutes the vocal sac, an organ capable of great ex-

FIG. 20. PICKERING'S TREE TOAD
From specimen in New York Zoölogical Park

pansion while the animal is uttering its shrill mating call. Length of body, $1\frac{1}{8}$ inches; total length, hind limbs outstretched, $2\frac{1}{2}$ inches.

Range: The entire eastern and central portions of the United States, abundant.

Local Distribution: Common, but not easily seen.

Only three representatives of the genus *Hyla* are found in this vicinity.[1] The species are easily distinguished from one another by their characteristic color-patterns, and from other tailless batrachians by their peculiar feet and the disks on the toes.

[1] One species, the *Hyla andersoni*, is of doubtful occurrence, although it is included in this Leaflet.

With the first mild days of spring, the bogs and marshes resound with the cheery, piping notes of the males of this species, the peculiar character of which has given rise to the popular name of "Peeper." Specimens are difficult to find, since they hide among the blades of the coarse grass, and when disturbed take refuge in the water. After the breeding season the animals

Miss Mary Dickerson, Photo.

FIG. 21. ANDERSON'S TREE TOAD

leave the bogs and live among the leaves and low bushes and rank vegetation, and their sharp cries are seldom heard. To produce the piping cry, so intense and penetrating for so small a creature, the male fills his vocal sac with air until it is more than half the size of the body. Then the air is expelled with such energy that the sides of the tiny creature become hollow with the convulsive effort. The eggs of this species are deposited in small masses and hatch quickly. The tadpoles undergo a rapid metamorphosis.

Anderson's Tree Toad.

Anderson's Tree Toad, *Hyla andersoni* Baird (Fig. 21), is of moderate size. The disks on the toes are well developed. Bright pea-green above with a narrow, though very distinct, white border on the sides and upper surfaces of the limbs. A narrow, purplish brown band extends from behind each nostril, across the eye and to the base of the fore limb. The lower sides are purplish brown, though of a lighter shade than the band, and are ornamented with irregular spots of a lighter and richer hue. The abdomen is pinkish white, though its edges are suffused with the purple tinge of the sides.

This species is of great rarity, and but very few specimens have ever been captured. It is a most attractively colored creature, and on account of the pale green of the upper surface resembles the European Tree Toad. Mature specimens are from an inch and a quarter to an inch and a half in length.

Range: The species is so rare that its range has not yet been determined, but is supposed to extend from southern New York to Florida. The species has been found in South Carolina.

Local Distribution: One specimen has been taken at Jackson, N. J., another at May's Landing and still another (represented in the figure) at Lakehurst, in the same State.

Gray Tree Toad.

The Gray Tree Toad, *Hyla versicolor* Le Conte (Figs. 22 and 28), is of moderate size and stout form. The ends of the toes are disk-like and adhesive. Color above, usually pale lichen-gray, with large wavy and irregular markings of darker shade. On the hind limbs these darker markings are so disposed that they appear to form two bands when the limbs are folded. Abdomen uniform grayish white; lower portion of hind limbs tinged with bright yellow.

The skin is very rough and is covered with minute, warty points on the back. Male specimens differ from the females in having loose, dark skin under the throat.

The species exhibits great variation in color according to light, temperature and the temperament of the individual. From the pale, ashy gray ordinarily present, the color varies to brown, very dark gray, or to vivid green. With the variation

of color the pattern becomes obscure or more prominent. Length of body, 2 inches; total length with hind limbs outstretched, $4\frac{5}{8}$ inches.

Range: The entire eastern and central portions of the United States, from Maine to Florida, and westward to Texas.

Local Distribution: General and fairly abundant.

The call of the Gray Tree Toad is a loud clattering sound, and resembles the scolding of a frightened chipmunk or red squirrel. It is said that the Tree Toad is particularly vociferous before a coming rain. Like other prognosticators of the weather, however, these creatures are quite unreliable. Their cries are

FIG. 22. THE GRAY TREE TOAD
From specimen in New York Zoölogical Park

particularly frequent during the sultry intervals that follow a light summer shower. After the breeding season is over, this Tree Toad frequents trees and usually takes up its abode at some elevation above the ground. It is supposed to deposit its eggs during the latter part of May or early in June. Small weedy ponds are usually selected as breeding-places. The eggs hatch quickly and the transformation from the tadpole stage is rapid.

Salt-Marsh Frog.

The Salt-Marsh Frog, *Rana virescens* Kalm (Fig. 23), is of moderate size and rather slender form. Ground color bronze to olive or bright green, but always vividly marked with large and irregularly scattered round spots of dark brown or black; on the back several of these spots are very elongate. The spots are more regularly disposed on the hind limbs, and when the legs are flexed, they have a banded

appearance. Over each eye there is a rounded spot, placed slightly inwards towards the center of the head.

A raised, vein-like fold of skin extends from behind each eye to the end of the body and is pale bronze in color. A stripe of similar color extends on each side of the head from the tip of the snout to behind the earplate, where it terminates in a raised skin fold. The under parts are white, indistinctly mottled with gray about the limbs.

When examined from directly above, the arrangement of the spots on the back appears to be irregular. This character may be employed to distinguish the species from the Leopard Frog,

FIG. 23. THE SALT-MARSH FROG
From specimen in New York Zoölogical Park

which it resembles in form and pattern. On the Leopard Frog the spots are rather square in shape and are quite regularly disposed in rows down the back and the sides. Length of body, $3\frac{1}{2}$ inches; total length, hind limbs outstretched, 9 inches. These measurements were taken from a very large specimen. The average length of body is about $2\frac{3}{4}$ inches, and total length more than 7 inches.

Range: Maine to Texas. Several varieties of the species are recognized, some of which occur in the Western States, Mexico and Central America.

Local Distribution: Abundant in swampy situations near the coast.

The Salt-Marsh Frog, sometimes called the Field Frog, inhabits swampy meadows rather than large bodies of water, and is common in many brackish swamps in this vicinity, although it is also found in fresh-water swamps. It is particularly abundant in the Newark meadows. The vocal sacs of the males are

FIG. 24. THE LEOPARD FROG, OR PICKEREL FROG
From specimen in Am. Mus. Nat. Hist.

very prominent externally and become distended as the species gives voice to its sharp, rasping call.

Leopard, or Pickerel, Frog.

The Leopard Frog, or Pickerel Frog, *Rana palustris* Le Conte (Fig. 24), is of moderate size and rather slender form. Ground color above, pale brown, with four rows of large square spots, two rows down the back and one on each side. These spots are very dark brown or black. The hind limbs are banded with the same color, which is also present in irregular spots on the fore limbs. There is a large spot over each eye, and one directly over the snout. The upper lips are dark brown, and above this color there is a band of pale bronze.

Four ridges or elevated folds of the skin extend down the back, the two outer rows of which are vividly tinged with light bronze; the two inner folds traverse the centers of the rows of dark spots on the back. The abdomen is silvery white. The under surface of the hind limbs is bright yellow, as is also a small area behind each fore limb.

The species may be distinguished from the Salt-Marsh Frog by the regularity of the rows of spots. It is the most showy of our local frogs.

Range: Eastern North America.

Local Distribution: General.

The Leopard Frog is a wanderer, traversing and frequenting stretches of damp meadows and fresh-water swamps. It is sometimes found a considerable distance from the water. Young specimens are most numerous about shallow, slow-running streams bordered with dense vegetation.

When in danger this frog exudes through its skin an acrid secretion which protects the creature from its enemies. Few snakes eat these frogs. They are said, however, to be good bait for pickerel on account of their bright colors; hence one of the popular names, the "Pickerel Frog."

The Pond Frog, or Green Frog, *Rana clamata* Daubin (Fig. 25), is a large species. Form, stout. Dark brown or olive-green above, with an irregular sprinkling of darker spots; head usually bright green. White beneath, with an obscure marbling of gray about the under surface of the limbs; throat of the male generally yellow; of the female, white, marbled with gray. **Pond, or Green, Frog.**

The color of the individual varies with the changes in light and temperature. A common phase displays much vivid green about the head and anterior portion of the body, while the posterior portion is brown or olive. Sometimes the entire body is green, in other instances dull brown. The male may be distinguished from the female by his much larger earplate (tympanum).

This species resembles the Bull Frog, but may be readily distinguished therefrom by a marked anatomical character: on each side, beginning behind the eye and extending nearly the

entire length of the body, there is a vein-like ridge or fold of skin. The Pond Frog is, moreover, considerably smaller. Average length of body, $3\frac{1}{2}$ inches; total length, with limbs outstretched, $7\frac{3}{4}$ inches.

Range: Eastern and central United States and southern Canada.

Local Distribution: General and abundant.

With the possible exception of the Toad, the Pond Frog is the most familiar of our local batrachians. It is found everywhere and abundantly in ponds and streams, where its familiar

FIG. 25. THE POND FROG, OR GREEN FROG
From specimen in Am. Mus. Nat. Hist.

croaking may be heard during the summer months. The eggs are deposited in masses early in the spring. The jelly-like clusters containing the numerous black dots representing the developing embryos are familiar objects. The tadpoles are rather slow in growth, generally consuming two seasons before they complete their metamorphosis, according to the temperature of the water and its exposure to sunlight. In the fall the tadpoles burrow into the mud and hibernate. The average tadpole is three inches in length when the limbs are well advanced in growth, and the young frog, immediately after absorption of the tail, measures slightly more than an inch. Tadpoles

confined in indoor aquaria are much retarded in their growth, and many remain as such for a period of three years or more.

The Bull Frog, *Rana catesbiana* Shaw (Fig. 26), is very large and stout. Limbs short but powerful. Hind feet large and very fully webbed. Head wide. Color above, light olive, irregularly blotched or marbled with dark olive or brown. The intensity of these markings varies with individuals and the disposition of the individuals themselves. Limbs, especially the hind pair, with brown blotches which toward the extremities assume the form of bands. The under parts are silvery white, with grayish markings, the throat in many individuals assuming a yellowish tinge. The portion of the head between the mouth and the eyes is usually tinged with pale green; the upper surface, however, matches the general color of the body.

Bull Frog.

FIG. 26. THE BULL FROG
From specimen in New York Zoölogical Park

Half-grown specimens resemble the adult of the Pond Frog, but may be recognized by the absence of the vein-like fold of

skin which is present on each side of the body in that species. There is, in fact, no trace of this in the Bull Frog. A full-grown specimen will measure 14½ inches from the tip of the snout to the end of the outstretched limbs, and 6¾ inches when in a sitting position. Such a specimen would weigh about one pound.

Range: The eastern and central portions of the United States and southern Canada.

Local Distribution: General, but not so abundant as the Pond Frog.

The Bull Frog frequents larger bodies of water than the common Pond Frog, being especially partial to large ponds and slow-running rivers, where the banks are lined with overhanging vegetation in which it can find concealment. The tadpoles grow to a greater size than those of the Common Frog. They may be distinguished by their distinctly yellowish abdomen. During the hours of sunlight they have a habit of lying in shallows around the borders of the pond, but upon the slightest disturbance they scurry for deeper water with startling activity and swim close to the bottom in order to leave a trail of muddy water, agitated by the thrashing of their tails. This maneuver tends to conceal their exact location.

Bull Frogs, particularly young specimens, have a peculiar habit of emitting a sharp cry when disturbed on the bank, and instead of plunging directly into the water, they skim over the surface for a short distance. The Common Frog, on the other hand, when disturbed, jumps into the water and instantly dives to the bottom, where, with a quick kicking of the hind limbs, it stirs up a cloud of mud in which it can conceal itself.

The Bull Frog is a most voracious creature. Mature specimens do not hesitate to swallow any moving object of about their own size that may come within reach of the wide gape of their jaws. They are largely insectivorous, but birds and small rodents are frequently eaten. Captive specimens experience no difficulty in swallowing sparrows or half-grown rats.

The call of a Bull Frog differs from the ordinary "croak" of a Pond Frog. It is a deep, protracted bass, resembling the sound made by drawing a bow for half its length across the string of a bass-viol. The note is repeated four to six times.

The eggs of the Bull Frog are laid in May. During the latter part of July or in August of their second summer the tadpoles acquire limbs and leave the water as perfect frogs.

The Wood Frog, *Rana sylvatica* Le Conte (Fig. 27), is of small size. It is light brown above, with a dark brown spot on each side of the head. This spot extends from the snout through the eye (darkening the lower half of the iris), covers the earplate and adjacent area and terminates in a sharp angular outline with a fold of the skin behind

Wood Frog.

FIG. 27. THE WOOD FROG
From specimen in New York Zoölogical Park

the base of the fore limb. A whitish line in strong contrast with the dark color on the sides of the snout traverses the upper lip. There is a smaller dark spot near the base of the fore limb. The hind limbs are indistinctly banded on the upper surface. The abdomen is silvery white.

Two well-defined ridges, or vein-like folds, extend down the back of this easily-recognizable species. In different specimens the body color varies somewhat, some are distinctly reddish. The characteristic dark spot on each side of the head is always apparent, however, and facilitates identification. Length of body, $2\frac{1}{4}$ inches; total length, with hind limbs outstretched, $5\frac{3}{4}$ inches.

Range: Like many of the North American frogs, it is gener-

ally distributed over the eastern and central portions of the United States and southern Canada. It does not extend, however, into the sandy portions of the Southern States.

Local Distribution: The Wood Frog appears to be restricted to certain areas, in which it is abundant. The writer has found it common in the woods along the Palisades of the Hudson River and in Westchester County, N. Y.

The Wood Frog, even where it is abundant, is not often seen, on account of its habit of living among the fallen leaves of timbered districts and the fact that its sober colors almost precisely match the dead leaves. It is aquatic only in the spring, when it frequents small bodies of water for the purpose of laying its eggs. At such times the croaking of the many males indicate the first awakening of the cold-blooded creatures from their winter sleep, for the Wood Frog lays its eggs before the ice has entirely left the ponds. The writer has repeatedly observed them as early as March. The eggs are deposited in masses from two to three inches in diameter, and hatch within ten days. The tadpoles grow rapidly and, unless their pool receives the water from cold springs, complete their transformation early in the summer. They are black above and bright golden bronze beneath. Upon leaving the water the young frog is slightly more than half an inch in length.

FIG. 28. THE GRAY TREE TOAD
From specimen in New York Zoölogical Park
[52]

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AMERICAN MUSEUM OF NATURAL HISTORY

The Development of a Mollusk

By B. E. Dahlgren, D.M.D.

American Museum of Natural History

REPRINTED FROM THE AMERICAN MUSEUM JOURNAL

VOL. VI, No. 1, JANUARY, 1906

Guide Leaflet No. 21

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MODEL 21. FRONT VIEW

The fully formed mollusk larva, or veliger.

The Development

of a

Mollusk

A Guide to the Series of Models Illustrating the Development of Crepidula in the Department of Invertebrate Zoölogy

By

B. E. DAHLGREN, D. M. D.

American Museum of Natural History

GUIDE LEAFLET No. 21.

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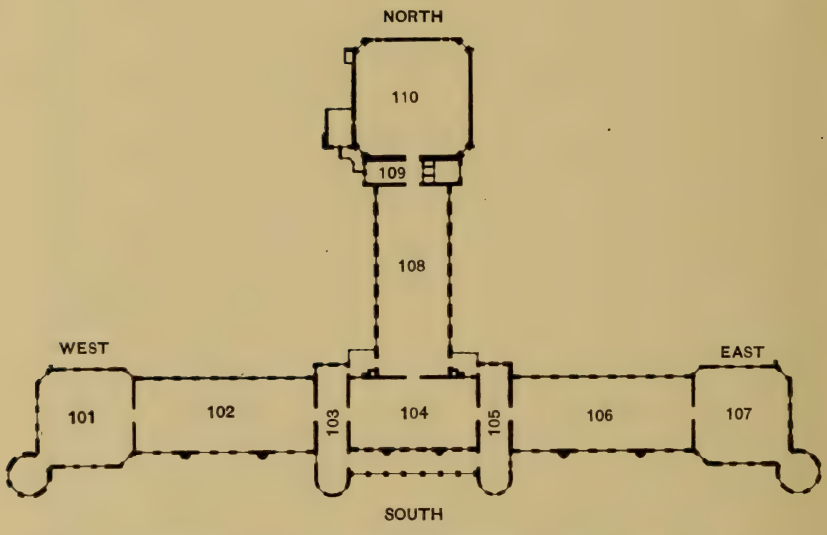


The models illustrating the development of a mollusk as shown in the life history of the Gastropod *Crepidula* are exhibited in the Hall of Invertebrate Zoölogy, No. 107 of the East Wing, first floor of the Museum building.

THE DEVELOPMENT OF A MOLLUSK.[1]

A GUIDE TO THE SERIES OF MODELS ILLUSTRATING THE DEVELOPMENT OF CREPIDULA.

By B. E. Dahlgren, D.M.D.,
American Museum of Natural History.

Introduction.

THE problem of how living organisms arise must have ever presented itself to the questioning mind. The processes involved in the origin of new individuals nevertheless remained for ages an unsolved mystery. The most familiar example, the origin of the young bird from an egg, cannot have failed to arouse the interest even of primitive man. It must also have furnished the first suggestion towards an explanation. Although undoubtedly long unsuspected, in time it became known that every animal which does not multiply by simple division into two like the very lowest arises from an egg, which is either hatched or developed within the body of the parent. Until a century and a half ago it was generally believed that the egg contained a miniature animal, which became perfected during incubation. Not until the substance called protoplasm had been recognized as the universal "physical basis of life," and, by the aid of the microscope, all living bodies had been found to be composed of cells, was anything like a correct understanding of the nature of the egg and its development attained. The egg was found to be a cell derived like all other cells by the division of a preëxisting cell. Its development, resulting in the formation of the myriad cells of a new individual, was found to proceed by a process of cell-division, essentially similar to that by which growth takes place in the adult.

[1]Reprinted from *The American Museum Journal*, Vol. VI, pp. 28-53. Jan., 1906.

Out of the discovery of the character of the egg, of its origin from a parent cell and of its processes of development grew numerous other problems demanding the attention of investigators. Thus the science of embryology came into existence. This science seeks to discover every step in the development of an organism and to trace resemblances and differences of structure and form from their very earliest beginnings. It investigates the conditions which influence development and seeks to discover the factors which determine each step in the formation of an organism, to what extent development is dependent upon external causes and to what extent it is predetermined by the internal organization of the egg. It seeks to determine precisely what this internal organization is and to explain the manner in which the reproductive cell becomes the bearer of the characters of the parents and by what process it is able to transmit these to the offspring.

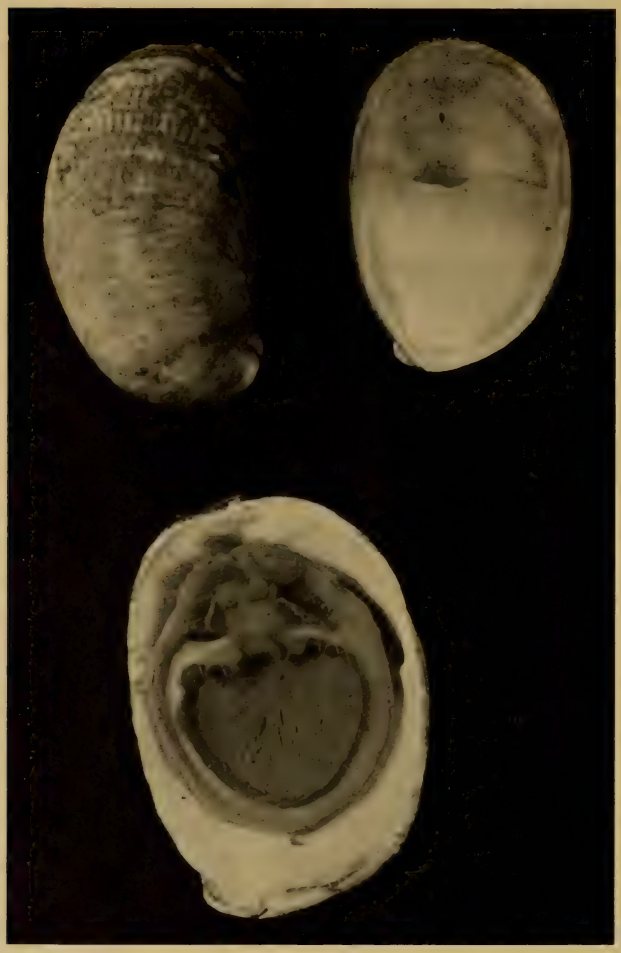
The comparison of the development of different animals soon revealed striking similarities at certain stages. It was found that after cell-division had proceeded to a certain extent the developing egg assumed a form resembling a mulberry (the morula); that later the cells invariably became arranged in the form of a hollow sphere (the blastula), this in turn giving rise to a somewhat more complicated flask-shaped form (the gastrula). It was seen that these various stages presented remarkable correspondences to certain lower forms of life. The analogy of the undivided egg to a simple unicellular protozoan; of the mulberry, or morula, stage to simple aggregations of unicellular animals such as are found among the lowest forms of life; of the blastula to certain Flagellates which occur in the form of hollow, free-swimming, multicellular spheres, and the apparent analogy of the gastrula to certain polyps led to the theory that the developing animal, in the course of its formation from the egg, passes successively through the forms of a whole series of lower organisms which may be considered as its ancestral types.

Formulated at a time when the evolution theory had been recently advanced, this corroborative theory aroused the liveliest interest. Although the original theory has been largely modified since the developmental history of a greater number of

forms has become known, comparisons such as these have thrown much light on the connections existing between various classes of animals, the extent to which developmental histories correspond being, in a degree, an index of relationships.

With a view primarily to increase the embryological evidences of evolution and at the same time to gain a clearer conception of relationships, the development of all the various types began to be traced from the original germ layers. Naturally the conditions which might influence development were considered, and explanations of how the mechanical action of simple physical factors, such as pressure, cohesion and gravity, might tend to cause a dividing egg of a given character to assume successively the various forms through which it passes during development, were soon advanced and received with great enthusiasm. To determine exactly how important a rôle these extrinsic factors play, and the extent to which the future form of an organism is predetermined by the intrinsic character of the egg is evidently of the greatest importance in the solution of the problem of heredity and constitutes at present one of the main problems of embryology.

Although the earlier embryologists were satisfied with simply tracing the origin of the various organs of the body from their primary germ layers which begin to be defined with the gastrula stage, nowadays the solution of the origin of every organ or feature of the body and the significance and factors of every step in development are sought by the most painstaking tracing of the history of every single cell arising by every succeeding division of the egg. It was with a purpose such as this that an elaborate and careful study of the development of *Crepidula* was undertaken by Prof. E. G. Conklin, of the University of Pennsylvania. This study has been followed by the author in constructing for the American Museum of Natural History the series of models described in the present paper.



THE SLIPPER LIMPET OR BOAT SHELL
Crepidula fornicata Lamarck

The Development of Crepidula.

The models represent on a greatly enlarged scale (about 400 diameters) the more important stages in the development of the egg of a gasteropod mollusk of the genus *Crepidula*—the Slipper Limpet, or Boat Shell—common on the coast of the United States. The exceedingly minute eggs (.182 mm. in diameter) are laid in great numbers in capsules secreted by the mollusk. These

capsules, to the number of 50 or 60, each containing about 250 eggs, are united into a grape-like cluster generally found under the shell of the Crepidula attached to the stone or other object upon which it lives its sedentary life. The total number of eggs laid at one time by an animal is about 13,000.

The unfertilized egg (Fig. *a*) is a nearly spherical single cell consisting of a very small amount of protoplasm surrounded by a relatively larger amount of yolk material, mostly in the form of small globules. Within the protoplasm, in a nearly central position, is found the nucleus of the cell. The whole egg is enveloped by a cell membrane.

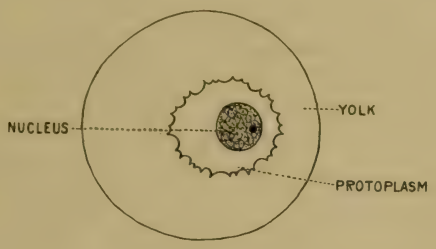


FIG. *a*

The first change which takes place in the egg, preparatory to development, is a migration of the nucleus and protoplasm from a central position toward the upper surface of the egg, the yolk, or deutoplasm, taking its position below it. The egg thus becomes distinctly symmetrical about a vertical axis (Fig. *b*). The upper pole, at which the protoplasm is found, is known as the *animal* pole; the opposite, or lower, as the *vegetative* pole, since

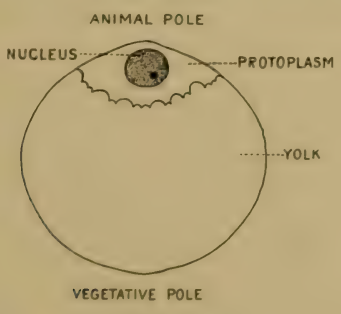
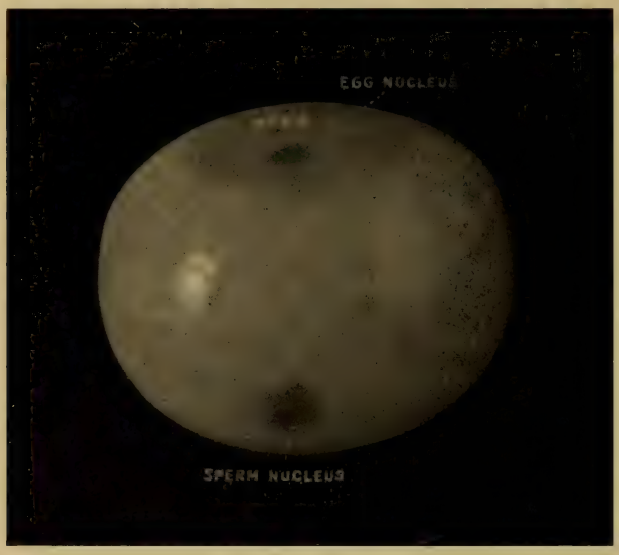


FIG. *b*

about this is collected the yolk or food material contained in the egg. This axis may be followed throughout the development and has been found to correspond to the dorso-ventral axis of the future larva.

About the time of the change in the position of the nucleus and protoplasm, a division of the former takes place. One of the portions resulting from this division, surrounded by a small amount of protoplasm, is extruded at the animal pole, where it remains for a time as a minute body. This is the "first polar



MODEL 1, A

The individual egg showing the clear protoplasmic area above, under the two polar bodies; the yolk with the yolk globules below. In the protoplasm at the animal pole is seen the egg nucleus. The sperm nucleus is represented shortly after entering the lower half of the egg.

body" and is the larger of the two adherent bodies shown in Model 1,B.

This process of division of the nucleus is soon repeated, and a second smaller polar body is extruded. These two polar bodies remain in position for a considerable length of time. Although they do not take any part in the future development, becoming ultimately detached and lost, their elimination is of

particular significance in the preparation of the eggs for fertilization. The process is known as the "maturation" of the egg.

The sperm cells are inclosed with the ova in the capsules. They consist chiefly of a nucleus with a very insignificant amount of protoplasmic substance. A single sperm cell enters the ovum somewhere about the vegetative pole, at the time of the beginning of the maturation process, and its nucleus gradually makes its way upward toward the egg nucleus, until the two nuclei are in contact. These nuclei, known as the "pronuclei" of the egg, may be seen in Model 1,B lying close together in the protoplasm at the animal pole. The egg is now fertilized and capable of developing into a new organism.

MODEL 1, B

The fertilized egg, showing the egg and sperm nuclei in contact at the animal pole. On either side of them are the centrospheres.

Each nucleus is composed largely of a peculiar substance, which has been given the name "chromatin," because of the readiness with which it assumes the stains used for coloring microscopic objects. Though little is known about the definite function and properties of chromatin, its importance is evidently very great, for it is found in the nuclei of all cells. Generally it is

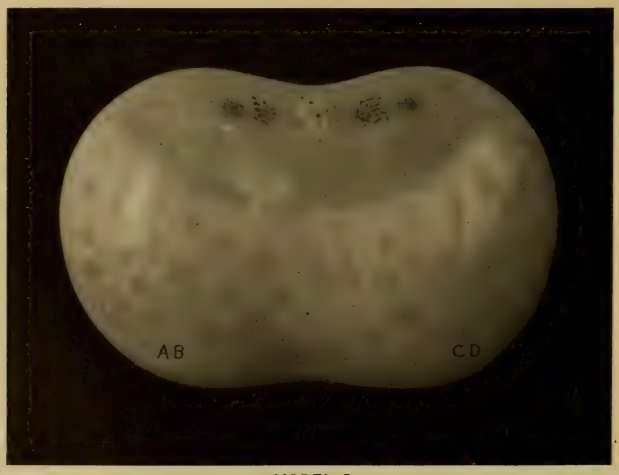
seen as small particles in the form of loops or bands, more or less compactly arranged, and of a definite number in any given species. To these the name "chromosomes" has been given. The division of a nucleus seems to consist mainly in a careful separation of the chromosomes into two equal parts.

There is also present in connection with each nucleus a small body which seems to be the center of all nuclear changes, the "centrosome." Whenever any activity of the nucleus such as a division takes place, the centrosome is in evidence.

Centrosomes are to be observed in both of the pronuclei of the undivided egg, and radiations apparently extend from them to each separate chromosome. The arrangement of the chromatin now becomes looser, and the chromosomes are more widely separated. The centrosomes come to lie in diametrically

FIG. *c*

opposite positions with the two pronuclei between them. The nuclear boundaries next disappear, the chromosomes become



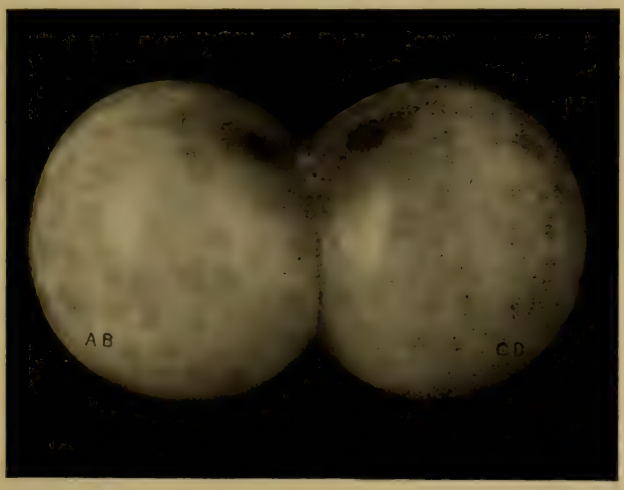
MODEL 2

First cleavage. Separation of chromosomes. Elongation and constriction of the egg preceding its complete division into two cells.

still farther separated, the radiations become more distinct, and soon seem to act on the chromosomes as two sets of fibers. The next step is a separation of every chromosome into two parts, which seem to be drawn in opposite directions toward the two centrosomes. These changes are shown in Model 2 and Fig. C.

In this manner two new nuclei are formed from the pronuclei, each new nucleus being composed of one-half of the chromatin of the male and female pronuclei, and each nucleus having a centrosome.

At the same time that the division of the pronuclei takes place a corresponding division of the whole egg occurs. The egg elongates (Model 2), a constriction takes place, and finally, coincident with the formation of the two new nuclei, there is



MODEL 3

Completion of first cleavage. Two cells. Polar bodies in the furrow between them. Daughter nuclei and centrospheres in each cell.

a complete separation of the egg into two halves, forming two new cells, each made up of protoplasm and yolk, like the single undivided egg, and each having a nucleus with its centrosome (Model 3). One of these two new cells gives rise to the anterior portion of the embryo, the other to the posterior.

Beginning with this, the first cleavage, up to the time when the larva is capable of taking in new food, the whole process of

MODEL 4

Resting stage after first cleavage. The two cells flattened against each other.

MODEL 5

Beginning of second cleavage. Nuclei resolved into division spindles. This model shows plainly two centrosomes, radiations and the two sets of chromosomes in each cell.

development proceeds through the repeated subdivision of these cells.

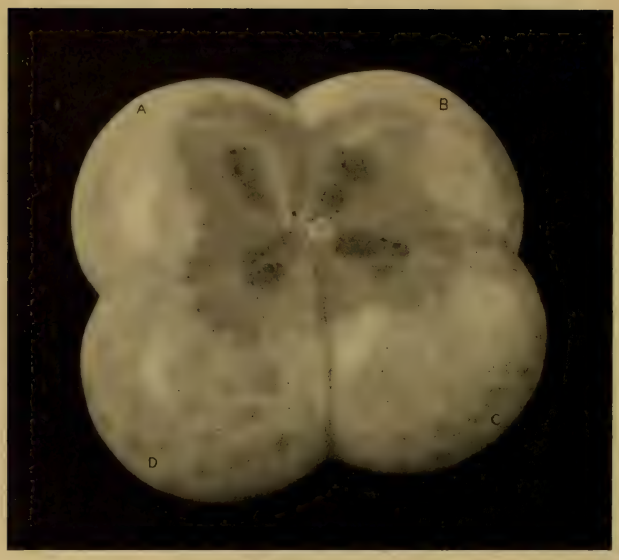
The second cleavage, which occurs at right angles to the first, divides the egg and the body of the future larva into right and left halves. This cleavage, initiated by a division of the centrosome, takes place by the changes in each nucleus, followed by an elongation and constriction of the cell. Finally a complete division of each nucleus and each cell into two parts takes place (Models 5 and 6). This gives four new cells, Model 7, each

MODEL 6

Second cleavage. Further separation of chromosomes. The two cells elongated and showing a constriction.

destined to form a definite part of the future organism, but each constituted as far as we can see in a precisely similar manner.

In the next, the third, cleavage the division takes place in a new direction. This, as indicated by the nuclear figures on Model 8, is oblique. Instead of a division into two equal parts, only a portion of the protoplasmic substance at the animal pole separates off, giving rise to four small cells which eventually lie above and slightly to the right of the four lower larger cells. (Model 9 shows the eight cells resulting from this cleavage.)



MODEL 7

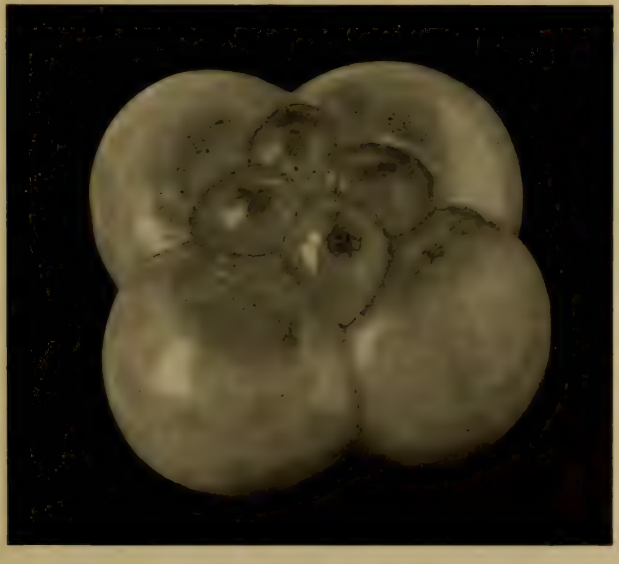
Second cleavage complete, so that four cells are formed.

MODEL 8

Third cleavage. Division spindles radial. The raised surface at the inner end of each spindle indicates the point at which four new cells will be separated off.

MODEL 9

Third cleavage completed. First quartet of small cells or ectoblasts formed.



MODEL 10

Fourth cleavage begun.

The fourth cleavage (Model 10) is also oblique. It results in the separation of another quartet of small protoplasmic cells slightly to the left of the large yolk-laden cells and also at the animal pole (Model 11).

The fifth cleavage is simply a division of the first quartet of small cells (Model 12).

By the sixth cleavage, the beginning of which is shown in Model 12, a third and last quartet of similar small cells is given off at the animal pole. This cleavage also is oblique, but to the right. By this alternation in the direction of each cleavage

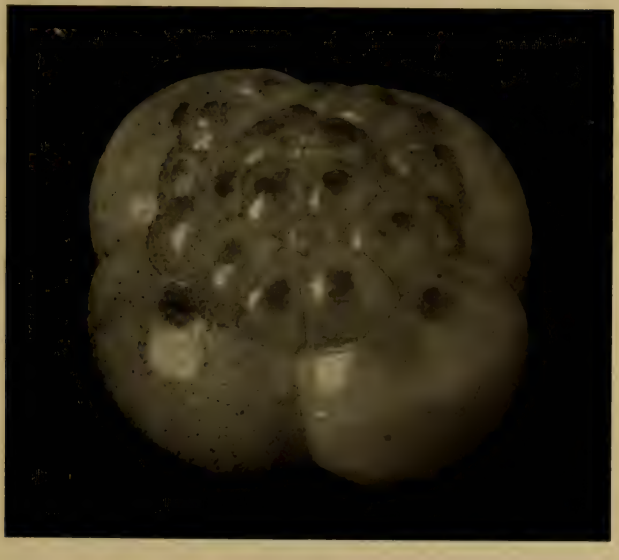
MODEL 11

Fourth cleavage completed. A second quartet of ectoblasts formed. Division beginning in cells of first quartet. Fifth cleavage begun.

plane, which began with first cleavage as indicated by the rotation of nuclei to the right, or in a clockwise direction on Model 4, the symmetrical arrangement of the cells is maintained. Lying at the animal pole of the egg, these three quartets of small cells form the so-called dorsal plate, which, by rapid multiplication of cells by division, is destined to grow until it completely covers the egg and forms the outer layer or ectoderm of the embryo. These cells are therefore known as "ectoblasts."

MODEL 12

Fifth cleavage completed. Sixth cleavage begun. Formation of third quartet of ectoblasts.

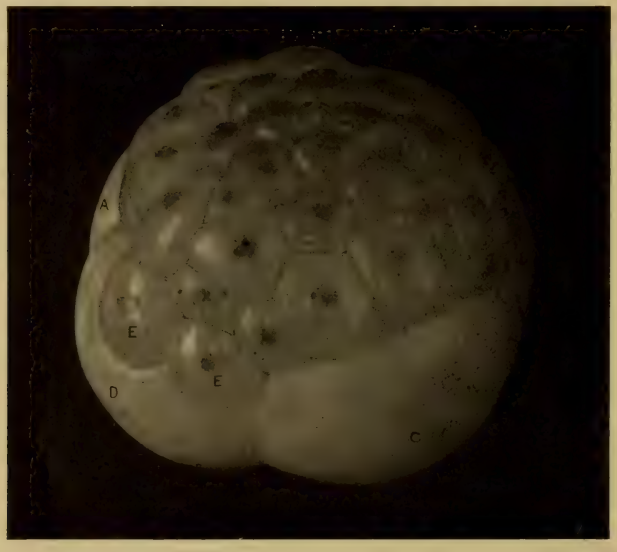


MODEL 13

Sixth cleavage completed. Second quartet has also divided; separation of ectoblasts completed.

MODEL 14

Separation from the left posterior large cell (D) of a single cell, the mesentoblast (M–E).



MODEL 15

Division of mesentoblast. The number of ectoblast cells has increased by further division of the three quartets.

The seventh cleavage (Model 12) divides the second quartet of ectoblasts.

The eighth cleavage (Model 13) consists of a second division of the first quartet of ectoblasts.

The ninth cleavage is unique, only one rather large cell, the "mesentoblast," M.-E. being separated off from the left posterior of the larger cells (D, Model 14). This new cell divides into two (Model 15) and again into four parts (Model 16). The upper two of these four cells, concealed on the model by the rim of the dorsal plate, multiply rapidly by division, and the cells which are formed from them make their way between the dorsal plate of the ectoblasts and the large yolk-laden cells below. They will form the future middle layer or mesoderm of the embryo, and

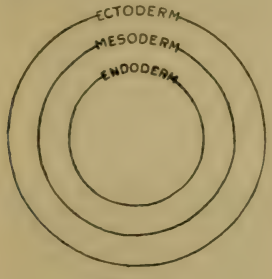


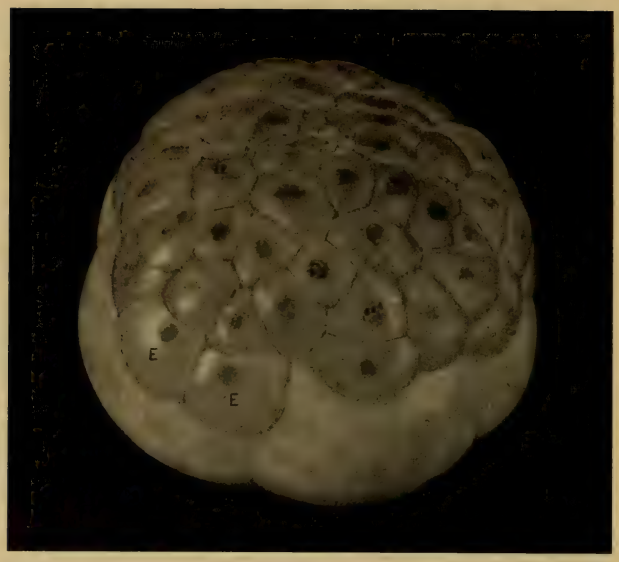
FIG. *d*

FIG. *e*

are known as the "mesoblasts." After the separation of the mesoblasts the remaining three large cells finally divide, giving in all eight or nine large inferior cells, the "entoblasts," which in time will form the inner layer of the embryo.

At an early stage there are thus separated in the egg the rudiments of the three layers distinguishable in the development of all higher animal organisms : ectoderm, mesoderm and endoderm. These may be diagrammatically represented as in Fig. *d*.

The ectoblasts by multiplication of cells soon extend over the entire ovum until only a narrow pore is left on the lower or ventral pole (Models 17, 18). Owing to the unequal rate of this growth, the upper or animal pole is at the same time shifted anteriorly till its angular distance from the lower vegetative pole becomes on this side only 90° (Model 18).



MODEL 16

Second division of mesentoblast, resulting in the formation of two mesoblasts and two entoblasts, which are concealed under the rim of the plate of ectoblasts, further divisions of ectoblast cell.

MODEL 17

Continued spreading of ectoblasts over the surface of the egg. Their origin from the three quartets is indicated in the model by colors: first quartet, red; second, blue; third, uncolored.

Immediately around the pore left by the closing of the edge of the ectoblasts is seen on this model the depression which indicates the beginning of the future mouth of the embryo. For a short time the pore itself is closed, but soon opens again and communication is thus established between the exterior and the internal cavity of the embryo. The structure of the embryo at this time may be represented diagrammatically as in Fig. *e*.

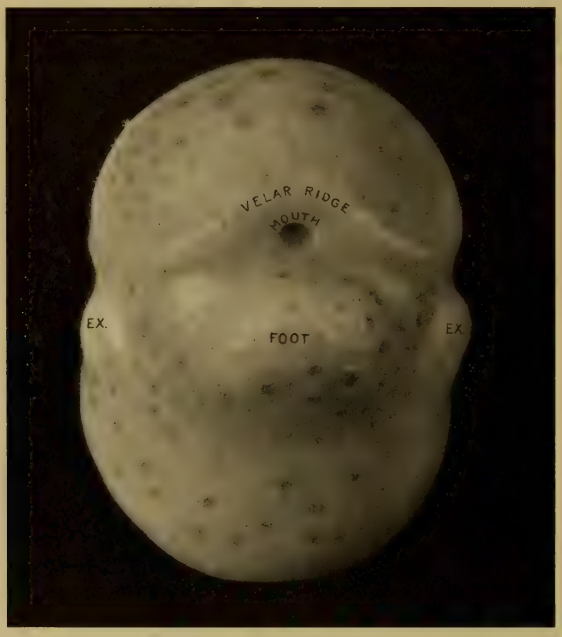
MODEL 18

The ectoblasts completely enclose the egg, leaving only a narrow pore (blastopore), about which is seen a depression. The derivation of ectoblasts from the three quartets indicated on the models by the coloring. The various regions of the future larva are becoming more sharply defined.

From this time on, the development consists of the differentiation by growth of the multiplying cells of these three separate layers into the specialized organs of the body.

The ectoderm cells which, as shown by the number of nuclei, are already very numerous, multiply rapidly in certain areas indicated by the slight outgrowths on the surface. These soon become more pronounced and form the beginning of the ectodermic organs of the embryo.

Above the mouth opening, which by this time is clearly defined, a ridge marks the beginning of the velum, or swimming organ, of the larva; below the mouth there is a large protuberance which will form the foot; at the sides of this two smaller knob-like outgrowths form the larval kidneys. At a point directly op-



MODEL 19

The larva begins to assume its definitive form. The mouth opening is formed; above it the curved edge of the velum is defined; below it the foot begins to protrude; on either side of this the first appearance of the larva kidney (EX) is indicated. At the lower pole of the model the shell gland is shown.

posite the apical, or head, end the shell gland develops (Model 18). Model 19 shows the shell beginning to be secreted by the shell gland.

The entoblast cells of the cavity of the gastrula by a process of unequal growth rapidly go to form the various parts of the digestive tube: stomach, liver, intestine etc. The œsophagus is formed by an invagination of the ectoderm from the exterior.

The middle layer, the mesoblastic layer, forms the muscles,

the circulatory system, heart and blood-vessels and the supporting tissues of the body.

Coincident with this differentiation of the regions of the body into organs, a change in the direction of the antero-posterior axis of the embryo takes place. The whole posterior portion is

MODEL 20

The formation of the veliger larva has proceeded farther. The various external organs are well defined. Below is seen the shell secreted by the underlying cells of the shell gland.

pushed ventrally: the mouth opening and the whole apical pole are shifted forward, and there is a twisting of the entire axis, plainly seen in the bending of the intestine. This organ, which originally lay in the mid-ventral line, assumes the form of an almost complete loop (Model 22). The asymmetry of the

mollusk larva is thus established and the definitive asymmetry of the adult is foreshadowed.

Models 21 and 22 show the completed larva, the free-swim-

MODEL 21. SIDE VIEW

The mollusk larva, or the veliger, completed. The velum, or swimming organ, about the anterior end bears two rows of cilia. The foot is large and prominent and bears on its under surface the lid, or operculum, by which the opening of the shell is closed when the animal withdraws into it. On the head are seen the two eyes. The two raised points near these mark the position of the feelers or tentacles.

ming veliger with its fully formed ciliated velum, or swimming organ, the shell and the large foot, bearing on its lower surface the operculum, or lid, by means of which the shell is closed when

the animal withdraws into it. On the head are seen the two eyes and near them the tentacles.

The veliger stage, though more or less suppressed in land mollusks, is common to all gastropods. By an additional series of changes, consisting in a continued growth and development in certain directions, this larva is ultimately metamorphosed into the adult form of its species.

MODEL 22

A section of the veliger showing the internal anatomy.

[27]

APPENDIX.

TECHNICAL DESCRIPTION OF THE MODELS.[1]

1. A. The ovum of *Crepidula* at the time of fertilization.

1. B. The fertilized ovum showing pronuclei lying in the cytoplasm at the animal pole. On either side of them the centrospheres. At the vegetative poles is seen the yolk-stalk. Jour. Morph., Vol. XIII, 1897, fig. 1.

2. First cleavage—appearance of first cleavage furrow. Jour. Morph., Vol. XIII, figs. 3, 4.

3. Completion of first cleavage furrow. Nuclei and asters opposite each other in the two blastomeres. Between the blastomeres are the polar bodies. Jour. Morph., Vol. XIII, fig. 5.

4. Resting stage after first cleavage. Flattening of blastomeres against each other. Dexiotropic turning of nuclei, asters and protoplasmic areas. Jour. Morph., Vol. XIII, fig. 7.

5. Beginning of second cleavage. Læotropic turning of spindles and protoplasmic areas. The centrospheres of preceding cleavage lie near the cleavage furrow. Jour. Morph., Vol. XIII, fig. 7.

6. Second cleavage. Beginning of second cleavage furrow. Læotropic rotation of spindles. Polar furrow being formed. Jour. Morph., Vol. XIII, fig. 9.

7. Completion of second cleavage. Asters nearly in position of poles of preceding spindles. Polar furrow well formed. Jour. Morph., Vol. XIII, fig. 10.

8. Third cleavage. Spindles almost radial, but showing slight dexiotropic rotation. Jour. Morph., Vol. XIII, fig. 12.

9. Third cleavage. Completion of first quartet. Position of asters shows that division was dexiotropic. Jour. Morph., Vol. XIII, fig. 13.

10. Fourth cleavage. Læotropic. First quartet has rotated into furrows between macromeres. Jour. Morph., Vol. XIII, fig. 14.

11. Fourth cleavage complete. Fifth cleavage, læotropic division of first quartet of micromeres and formation of "turret cells" (trochoblasts). Jour. Morph., Vol. XIII, fig. 16.

12. Fifth cleavage complete. Sixth cleavage dexiotropic. Formation of third and last quartet of ectomeres. Sixteen cells. Jour. Morph., Vol. XIII, fig. 17.

[1] The models correspond to the figures in "The Development of Crepidula," by Dr. E. G. Conklin, Jour. Morph., Vol. XIII, 1897, and "Karyokinesis and Cytokinesis," Jour. Acad. Nat. Sci., 2d Ser., Vol. XII, Phila., 1902.

13. Sixth cleavage complete. Division of second quartet complete. Quadrangular plate of ectomeres with angles of plate in furrows between macromeres. Twenty ectomeres (4 apical, 4 turret and 12 belt cells) and 4 macromeres. Jour. Morph., Vol. XIII, figs. 19, 20.

14. Formation of first member of fourth quartet, the mesentoblast, from the left posterior macromere; formation of basal cells of cross by the second division of first quartet. Jour. Morph., Vol. XIII, figs. 22, 23.

15. Division of the mesentoblast completed, dexiotropic. Second and third quartets. Turret cells formed. Forty-two cells: 4 apicals 8 cross, 4 turret, 20 belt cells, 2 mesentoblasts, 4 macromeres. Jour. Morph., Vol. XIII, fig. 29.

16. Fourth quartet completed by læotropic cleavage of macromeres, A, B and C. The two mesentoblasts of the preceding stage have divided, forming the two enteroblasts and two primary mesoblasts which lie immediately above the latter, but concealed by the plate of ectoblasts. Jour. Morph., Vol. XIII, fig. 31.

17. Further division of ectoblasts. Expansion of arms a, b and c of ectoblastic cross into a cell plate. Anterior shifting of apical cells. Posterior turret cells undivided. Formation of quadrangular blastopores, the enteroblasts in posterior angle. Jour. Morph., Vol. XIII, figs. 51, 52.

18. Later stage. Apex on ventral side, slightly to the right. Cells of ectoblastic cross, first quartet, cover the whole anterior end of embryo. Large cells of posterior arm, dorsal. The closing of the blastopore and a depression about it indicating the formation of the stomodæum. The superior rows of ectoblast cells of second quartet, directly above the blastopore, form the first and second velar rows. The shell gland is forming at the postero-dorsal and somewhat to the left. Jour. Morph., Vol. XIII, figs. 65, 74, 75.

19. Older embryo, showing apical, posterior and pedal cell plates. On either side to the anterior and posterior of the dorsal cell plate, the velar rows are branching. Mouth and the external kidneys are formed, the shell gland expanding. Jour. Morph., Vol. XIII, figs. 76 to 79.

20. Older stage-formation of velum and foot. The shell gland greatly expanded and forming the shell of the veliger. Jour. Morph., Vol. XIII, figs. 80–82.

21. The fully formed veliger.

22. Section of the preceding.

The American Museum Journal

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AMERICAN MUSEUM OF NATURAL HISTORY

The Birds of the Vicinity of New York City

BY

Frank M. Chapman

Associate Curator, Department of Mammalogy and Ornithology

REPRINTED FROM THE AMERICAN MUSEUM JOURNAL
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THE LABRADOR DUCK
Group, Hall No. 208

The Birds of the Vicinity of New York City

A Guide to the Local Collection
in the
Department of Ornithology

By
FRANK M. CHAPMAN
Associate Curator of Mammalogy and Ornithology

GUIDE LEAFLET No. 22
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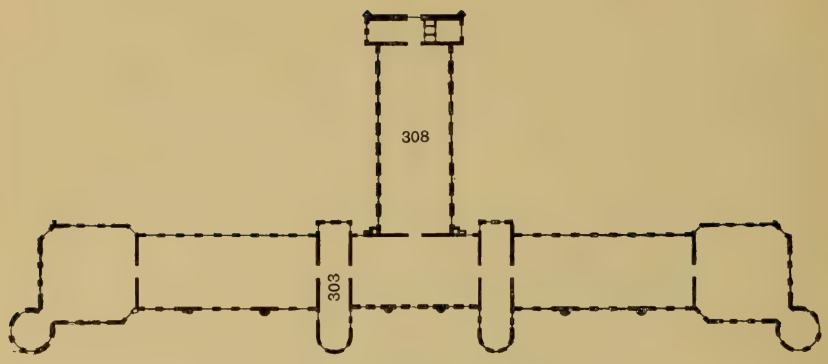

THIRD, OR GALLERY FLOOR.

Key-plan of the Museum building, showing the location of the halls in which the specimens and groups may be found to which references are made in this Guide Leaflet. Some of the groups are in Hall No. 208 of the Second Floor, directly under Hall No. 308 of this plan.

CONTENTS.

		Page.
Introduction	81	[5]
Permanent Residents	85	[9]
Summer Residents	85	[9]
Summer Visitants	86	[10]
Winter Residents	87	[11]
Winter Visitants	87	[11]
Regular Transient Visitants	88	[12]
Irregular Transient Visitants	89	[13]
Accidental Visitants	89	[13]
The Seasonal Collection	90	[14]
January Bird-Life	93	[17]
February Bird-Life	93	[17]
March Bird-Life	94	[18]
April Bird-Life	95	[19]
May Bird-Life	96	[20]
June Bird-Life	97	[21]
July Bird-Life	98	[22]
August Bird-Life	98	[22]
September Bird-Life	99	[23]
October Bird-Life	100	[24]
November Bird-Life	101	[25]
December Bird-Life	102	[26]
Annotated List of Local Birds	133	[27]
Bibliography With Critical Notes	191	[85]
Index	193	[91]

THE BIRDS OF THE VICINITY OF NEW YORK CITY.[1]

By Frank M. Chapman.

Associate Curator of Mammalogy and Ornithology.

Introduction.

The collection which this Guide is intended to accompany has been formed especially to aid students in identifying the birds found in the vicinity of New York City. It occupies a portion of the West Corridor of the third floor (Hall No. 303). With a few exceptions, all the specimens contained in it were collected within 50 miles of the American Museum of Natural History. The species which we have as yet been unable to secure within these limits are represented temporarily by specimens from the North American Collection. The collection is placed under two heads: first, systematic, containing virtually all the birds which have been recorded from within the prescribed limits, and second, seasonal, in which only the birds of the month are exhibited, as is explained more fully beyond. Species of accidental occurrence, or those which have been found in this vicinity but once or twice, are grouped at the end of the systematic collection.

The birds are labeled in accordance with the system of nomenclature adopted by the American Ornithologists' Union. The number on the label, preceding the name of each species is its number in the Union's "Check-List" of North American birds (2nd edition, 1895). In the desk case in the center of the hall will be found a local collection of the nests and eggs of the birds which breed within 50 miles of the Museum. It is labeled on the same plan as the local collection of birds. Near by are placed photographs from nature of the nests of most of our breeding birds and exhibits of bills, feet, wings, tails and feathers designed to explain technical terms used in descriptive ornithology. A list of useful ornithological publications will also be found here.

[1] Reprinted from the *American Museum Journal*, Vol. VI, pp. 81-102, April, 1906.

The appended annotated list of the species known to occur within a radius of 50 miles of the Museum is based on information derived for the most part from four sources: (1) previously published records; (2) the author's notes covering a period of twenty years' intermittent observation, mainly at Englewood, N. J.; (3) the observations of Mr. Waldron DeWitt Miller at Plainfield, N. J.; and (4) information received from Mr. William Dutcher. For many years Mr. Dutcher has made a specialty of the study of Long Island birds and has brought together a vast amount of data concerning them.

As a matter of local interest an asterisk (*) has been placed before those species which have been observed in Central Park. This list of Park birds is based on published records, the author's observations and information received from Messrs. C. G. Abbott, S. H. Chubb and B. S. Bowdish.

The text cuts with which this Guide is illustrated, with the exception of the Starling, are from Coues's "Key to North American Birds." For their use the Museum is indebted to Messrs. Dana Estes and Company, the publishers of that work. The full page plates are from photographs of Museum exhibits.

The region embraced within our limits possesses natural advantages calculated to attract a great number of birds. Our seacoast, with its sandy beaches and shallow bays; our rivers, creeks and ponds, with their surrounding grassy marshes; our wooded hillsides and valleys; our rolling uplands and fertile meadows, offer haunts suited to the wants of most birds. Again, our coastline and the Hudson River valley form natural highways of migration regularly followed by birds in their journeys to and from their summer homes.

The exceptional abundance of birds in this vicinity, however, is not due alone to the varied character of the country, or to the fact that twice each year streams of migrants pass along our coasts and through our valleys. There are certain causes which tend to limit the ranges of animals, chief among which is temperature. A study of the ranges or habitats of animals and plants shows that the boundaries of the areas inhabited by many species coincide with one another and also to a greater or less extent with lines of equal temperature. The ranges of these species being thus governed by natural causes, they are taken as indices of the limits of faunas or natural life-areas. The

lines between these faunas cannot, of course, be sharply drawn. The change from one to another is gradual, and between the two a neutral strip exists in which will be found species characteristic of each. Just such a condition is found in this vicinity, the northern boundary of the Carolinian Fauna over-lapping the southern boundary of the Alleghanian Fauna in the valleys of the Delaware, Hudson and Connecticut. In other words, we have here on the one hand a number of birds which are found no farther north and on the other certain species which are found no farther south; that is, in the breeding season, for among birds only the nesting ranges are of value in determining the boundaries of faunas.

The southern limit of the Carolinian Fauna on the Atlantic Coast is near Norfolk, Virginia; its northern limit, on the coast, as said above, is in the vicinity of New York City. To be more exact, a careful study of the nesting ranges of certain species shows that the most northern points at which they are regularly found is Port Jervis in the Delaware valley, Fishkill in the Hudson River valley, and Portland in the Connecticut River valley. These localities then may be considered as defining the northern limits of the Carolinian Fauna in the valleys in which they are placed. In the more elevated country between these points it is doubtful if the limits of the fauna reach quite as far north, for river valleys, both because they offer a natural pathway for the extension of a bird's range, and because of the higher temperature prevailing in them, tend to carry northward the boundaries of faunas. Eastward, along the Connecticut shore, the Carolinian Fauna may reach the mouth of the Thames. Long Island, although farther south, belongs for the most part in the Alleghanian rather than the Carolinian Fauna. Numbers of species common and even abundant in the Lower Hudson valley are exceedingly rare on Long Island, especially on the southern shore. But along the northern shore, or older part of the island, where deciduous trees abound, there is an evident trace of the Carolinian Fauna shown by the regular occurrence of the Blue-winged Warbler and the Acadian Flycatcher.

The following Carolinian birds are found every summer within 50 miles of the Museum, and all but two or three are known to nest regularly here. Their occurrence as breeding birds northward beyond these limits is, with but few exceptions, rare and irregular.

Clapper Rail.
King Rail.
Turkey Vulture.
Barn Owl.
Acadian Flycatcher.
Fish Crow.
Cardinal.
Rough-winged Swallow.
Worm-eating Warbler.
Blue-winged Warbler.
Louisiana Water-Thrush.
Kentucky Warbler.
Hooded Warbler.
Mockingbird.
Carolina Wren.
Tufted Titmouse.
Carolina Chickadee.
Blue-gray Gnatcatcher.

The southern limit of the Alleghanian Fauna on the coast is less clearly defined. It includes, however, Long Island and northern New Jersey. Its boundaries may be determined by the presence in the breeding season of the following species, few of which are known to nest at sea-level south of our limits:

Carolina Rail.
Alder Flycatcher.
Least Flycatcher.
Bobolink.
Savanna Sparrow.
Rose-breasted Grosbeak.
Purple Finch.
Golden-winged Warbler.
Nashville Warbler.
Chestnut-sided Warbler.
Black-throated Green Warbler.
Wilson's Thrush.

Thus it will be seen that while the region south of our district has the Carolinian species mentioned, and the region to the northward has the Alleghanian species just given, we, in this intermediate strip, have both Carolinian and Alleghanian species.

It is evident, therefore, that from an ornithological standpoint we are most favorably situated, and a comparison of the number of birds found within our limits with the numbers recorded from other districts shows that the causes mentioned have been effective in giving us an unusually rich avifauna. Due allowance must of course be made for the much greater area included in all but one of the regions used in comparison.

Recorded from	within 50 Miles of New York City	353
"	" District Columbia (Richmond, MS.)	281
"	" Ontario, Canada, (McIlwraith)	316
"	" Massachusetts (Howe and Allen)	362
"	" Illinois (Ridgway)	352
"	" Indiana (Butler)	305
"	" Michigan (Cook)	332
"	" Kansas (Goss)	343

During the course of a year the bird-life of our vicinity is subject to great changes. Some birds are always with us, some come for the summer, others pass us in the spring and fall in traveling to and from their more northern homes, and others still come

only in the winter. Our birds may thus be arranged, according to the season when they are present, in several rather well-defined groups, for which the following names seem most applicable.

I. Permanent Residents.—This class includes species which are with us throughout the year, but it does not follow that the same individuals pass the entire year here. Comparatively few, indeed, of the species in this group are permanent residents in the strict sense of the term. The Bob-white, Ruffed Grouse, and several of the Owls are doubtless literally permanent residents, that is, the same individuals pass their lives in one restricted locality, but it is not probable that the Bluebirds, for example, found here during the winter are the same birds which nested with us in the summer. Doubtless our winter Bluebirds pass the summer farther north, while our summer Bluebirds winter farther south but as a species, the Bluebird is a permanent resident.

List of Permanent Residents.

Bob-white.
Ruffed Grouse.
Marsh Hawk.
Sharp-shinned Hawk.
Cooper's Hawk.
Red-tailed Hawk.
Red-shouldered Hawk.
Broad-winged Hawk.
Bald Eagle.
Duck Hawk.
Sparrow Hawk.
Long-eared Owl.
Barred Owl.
Screech Owl.
Great Horned Owl.
Hairy Woodpecker.
Downy Woodpecker.
Flicker.
Blue Jay.
American Crow.
Fish Crow.
Starling.
Meadowlark.
House Sparrow.
Purple Finch.
American Goldfinch.
European Goldfinch.
Song Sparrow.
Swamp Sparrow.
Cardinal.
Cedar Waxwing.
Carolina Wren.
White-breasted Nuthatch.
Tufted Titmouse.
Chickadee.
Robin.
Bluebird.

II. Summer Residents.—Summer residents, as the name implies, are birds found here during the summer. They may, however, arrive early in March and remain until December, as do the Blackbirds and the Woodcocks, or they may not come until May and may leave us in August. Summer residents, then, are birds which come to us at varying times in the spring and after nesting here return to more southern winter resorts in the fall.

List of Summer Residents.

Wood Duck.
American Bittern.
Least Bittern.
Green Heron.
Black-crowned Night Heron.
King Rail.
Clapper Rail.
Virginia Rail.
Sora.
Yellow Rail.
Black Rail.
Woodcock.
Bartramian Sandpiper.
Spotted Sandpiper.
Kildeer.
Piping Plover.
Mourning Dove.
Osprey.
Barn Owl.
Yellow-billed Cuckoo.
Black-billed Cuckoo.
Belted Kingfisher.
Red-headed Woodpecker.
Whip-poor-will.
Nighthawk.
Chimney Swift.
Ruby-throated Hummingbird.
Kingbird.
Crested Flycatcher.
Phœbe.
Wood Pewee.
Acadian Flycatcher.
Alder Flycatcher.
Least Flycatcher.
Bobolink.
Cowbird.
Red-winged Blackbird.
Orchard Oriole.
Baltimore Oriole.
Purple Grackle.
Vesper Sparrow.
Savanna Sparrow.
Grasshopper Sparrow.
Henslow's Sparrow.
Sharp-tailed Sparrow.
Seaside Sparrow.
Chipping Sparrow.
Field Sparrow.
Towhee.
Rose-breasted Grosbeak.
Indigo Bunting.
Scarlet Tanager.
Purple Martin.
Cliff Swallow.
Barn Swallow.
Tree Swallow.
Bank Swallow.
Rough-winged Swallow.
Red-eyed Vireo.
Warbling Vireo.
Yellow-throated Vireo.
White-eyed Vireo.
Black and White Warbler.
Worm-eating Warbler.
Blue-winged Warbler.
Golden-winged Warbler.
Parula Warbler.
Yellow Warbler.
Chestnut-sided Warbler.
Black-throated green Warbler.
Pine Warbler.
Prairie Warbler.
Ovenbird.
Louisiana Water-Thrush.
Kentucky Warbler.
Maryland Yellow-throat.
Yellow-breasted Chat.
Hooded Warbler.
Redstart.
Catbird.
Brown Thrasher.
House Wren.
Short-billed Marsh Wren.
Long-billed Marsh Wren.
Wood Thrush.
Wilson's Thrush.

III. Summer Visitants.—Comparatively few birds fall into this group. As a rule the northern limit of their breeding range is not far south of our southern boundaries and they sometimes

visit us in small numbers, generally after their breeding season is over. In this group may also be placed the Shearwaters and Petrels, some of which are known to nest in the Antarctic Regions during our winter. In the spring they migrate northward and pass the summer off our coasts.

List of Summer Visitants.

Gull-billed Tern.
Royal Tern.
Forster's Tern.
Sooty Tern.
Black Skimmer.
Greater Shearwater.
Audubon's Shearwater.
Sooty Shearwater.
Wilson's Petrel.
American Egret.
Little Blue Heron.
Wilson's Plover.
Oyster-catcher.
Turkey Vulture.
Red-bellied Woodpecker.
Summer Tanager.
Carolina Chickadee.
Blue-gray Gnatcatcher.
Mockingbird.

IV. Winter Residents.—Winter residents, like summer residents, may arrive long before and remain long after the season which gives them their name. Our Junco, or Snowbird, for example, comes from the north in September and remains until April, but is a typical winter resident. That is, it arrives in the fall and after passing the entire winter with us returns to its more northern summer home in the spring.

List of Winter Residents.

Holbœll's Grebe.
Horned Grebe.
Loon.
Red-throated Loon.
Razor-billed Auk.
Kittiwake Gull.
Glaucous Gull.
Great Black-backed Gull.
Herring Gull.
Ring-billed Gull.
Green-winged Teal.
American Golden-eye.
Buffle-head.
Old-Squaw.
King Eider.
American Scoter.
White-winged Scoter.
Surf Scoter.
Purple Sandpiper.
Rough-legged Hawk.
Saw-whet Owl.
Horned Lark.
Prairie Horned Lark.
American Crossbill.
Redpoll.
Pine Siskin.
Snowflake.
Lapland Longspur.
Ipswich Sparrow.
White-throated Sparrow.
Tree Sparrow.
Junco.
Northern Shrike.
Myrtle Warbler.
Winter Wren.
Brown Creeper.
Canadian Nuthatch.
Golden-crowned Kinglet.

V. Winter Visitants.—Winter visitants are birds which may or may not visit us during the winter. As a rule, their presence

depends upon the severity of the winter. An unusually severe season sometimes forces boreal birds southward and they then may be found in numbers south of their regular winter range.

List of Winter Visitants.

Puffin.
Black Guillemot.
Brunnich's Murre.
Dovekie.
Iceland Gull.
Kumlien's Gull.
Cormorant.
Harlequin Duck.
American Eider.
Goshawk.
Black Gyrfalcon. (?)
Hawk Owl.
Snowy Owl.
Evening Grosbeak.
Pine Grosbeak.
White-winged Crossbill.
Holbœll's Redpoll.

VI. Regular Transient Visitants.—The birds of this class are found here only during the migrations. Their summer homes are north of us, their winter homes are south of us, and we see them only when they pass northward on their spring migration and southward on their fall migration.

List of Regular Transient Visitants.

Pied-billed Grebe.
Pomarine Jaeger.
Parasitic Jaeger.
Long-tailed Jaeger.
Laughing Gull.
Bonaparte's Gull.
Common Tern.
Roseate Tern.
Caspian Tern.
Cory's Shearwater.
Leach's Petrel.
Gannet.
Double-crested Cormorant.
Red-breasted Merganser.
Hooded Merganser.
Black Duck.
Blue-winged Teal.
Pintail.
Redhead.
American Scaup Duck.
Lesser Scaup Duck.
Ruddy Duck.
Canada Goose.
Brant.
Great Blue Heron.
Florida Gallinule.
Coot.
Red Phalarope.
Tennessee Warbler.
Cape May Warbler.
Black-throated Blue Warbler.
Dowitcher.
Long-billed Dowitcher.
Stilt Sandpiper.
Knot.
Pectoral Sandpiper.
White-rumped Sandpiper.
Least Sandpiper.
Red-backed Sandpiper.
Semipalmated Sandpiper.
Western Sandpiper.
Sanderling.
Greater Yellow-legs.
Yellow-legs.
Solitary Sandpiper.
Willet.
Hudsonian Curlew.
Black-bellied Plover.
Golden Plover.
Semipalmated Plover.
Turnstone.
Pigeon Hawk.
Short-eared Owl.
Yellow-bellied Woodpecker.
Magnolia Warbler.
Bay-breasted Warbler.

Northern Phalarope.
Wilson's Snipe.
Olive-sided Flycatcher.
Yellow-bellied Flycatcher.
Rusty Blackbird.
Bronzed Grackle.
Nelson's Sharp-tailed Sparrow.
Acadian Sharp-tailed Sparrow.
White-crowned Sparrow.
Lincoln's Sparrow.
Fox Sparrow.
Philadelphia Vireo.
Blue-headed Vireo.
Nashville Warbler.
Black-poll Warbler.
Blackburnian Warbler.
Palm Warbler.
Yellow Palm Warbler.
Water-Thrush.
Connecticut Warbler.
Mourning Warbler.
Wilson's Warbler.
Canadian Warbler.
Titlark.
Ruby-crowned Kinglet.
Gray-cheeked Thrush.
Bicknell's Thrush.
Swainson's Thrush.
Hermit Thrush.

VII. Irregular Transient Visitants.—These birds occur irregularly during the migrations. With certain exceptions they are birds of the interior and breed in the northern United States and British Provinces. Their regular line of migration is down the Mississippi Valley, and their occurrence on the Atlantic coast is more or less infrequent. Here are also included species formerly common near New York, but now practically extinct within our limits, where, however, they are sometimes found.

List of Irregular Transient Visitants.

Least Tern.
Black Tern.
Mallard.
Gadwall.
American Widgeon.
Shoveller.
Canvasback.
Ring-necked Duck.
Greater Snow Goose.
Blue Goose.
American White-fronted Goose.
Hutchins's Goose.
Black Brant.
Whistling Swan.
Wilson's Phalarope.
American Avocet.
Baird's Sandpiper.
Marbled Godwit.
Hudsonian Godwit.
Buff-breasted Sandpiper.
Long-billed Curlew.
Eskimo Curlew.
Passenger Pigeon.
Golden Eagle.
Migrant Shrike.
Orange-crowned Warbler.
Grinnell's Water-Thrush.

VIII. Accidental Visitants.—The homes of the birds included in this class are so far removed from our boundaries that their presence here at any time can be considered only as purely accidental. In most cases it is doubtless due to the agency of storms or high winds which drive migrating birds from their course. One-fourth the number given below are Old World birds, and about one-half the total number have been found here but once.

List of Accidental Vistants.

Black-throated Loon.
Ivory Gull.
Little Gull.
Sabine's Gull.
Fulmar.
Booby.
White Pelican.
Brown Pelican.
European Widgeon.
European Green-winged Teal.
Rufous-crested Duck.
Barnacle Goose.
White Ibis.
Glossy Ibis.
Snowy Heron.
Yellow-crowned Night Heron.
Corn Crake.
Purple Gallinule.
Black-necked Stilt.
European Woodcock.
Curlew Sandpiper.
Ruff.
Lapwing.
Ground Dove.
Black Vulture.
Swallow-tailed Kite.
Swainson's Hawk.
White Gyrfalcon.
Great Gray Owl.
Red-cockaded Woodpecker.
Pileated Woodpecker.
Arkansas Kingbird.
Raven.
Chestnut-collared Longspur.
Lark Sparrow.
Blue Grosbeak.
Painted Bunting.
Dickcissel.
Louisiana Tanager.
Bohemian Waxwing.
Prothonotary Warbler.
Cerulean Warbler.
Yellow-throated Warbler.
Townsend's Solitaire.
Varied Thrush.
Wheatear.

Summary.

Permanent Residents	34
Summer Residents	86
Summer Visitants	19
Winter Residents	38
Winter Visitants	17
Regular Transient Visitants	86
Irregular Transient Visitants	27
Accidental Visitants	46
Total,	353

THE SEASONAL COLLECTION.

The preceding seasonal analysis of our avifauna shows that only a part of the 353 birds which have been recorded from this vicinity are present at one time, and any arrangement of specimens which will, for example, show only the birds of a given month, will of course greatly simplify the problem of identification by excluding from it all species which, for seasonal reasons, we should not expect to find during the month in question.

The Seasonal Collection is made up of the Permanent Residents (Cases Q and O) and Migrants (Case P) and is changed

91 [13]

BLACK DUCK
Group, Hall No. 208

each month. Thus, in February, it is composed of the ever-present Permanent Residents together with the migrants which have come from the north to spend the winter. In March, the March migrants from the south are added, and a month later those which may be expected to arrive in April are included. In due time the winter birds are withdrawn and the transient migrants removed, until in June, the collection consists of the Permanent Residents and birds which have come from the south to spend the summer. A similar treatment is continued throughout the year and the collection always, therefore, represents the bird-life of the month in which it is seen.

The following outline of the bird-life of the year explains more fully the manner in which this Seasonal Collection is arranged, and at the same time, it may be used as a reference check-list in the study of local migration. It should be understood that the dates given represent those of a climatically normal year and that only the commoner water birds are included.

January Bird-Life.—Probably during no other month is there less movement among our birds than in January. The regular winter visitants have come; the fall migrants which may have lingered until December have gone, and the earliest spring migrants will not arrive before the latter part of February or in early March. In fact, January is the only month in the year in which, as a rule, some birds do not arrive or depart. This rule, however, may be broken by such irregular birds as the Pine Grosbeak and the Redpoll, and, south of New York, the Snowflake and the Crossbill, birds which may be wholly absent some winters and abundant others.

The only birds usually to be found in January, therefore, are the permanent residents and the regular winter visitants. Singing, mating, nesting, molting, migrating, events which in their season play so important a part in a bird's life, do not concern the birds of January. With them food is the one important question, and their movements at this season are governed solely by the food supply. Snow may fall and winds blow, but as long as the birds find enough to eat they give small heed to the weather. Food, therefore, rather than temperature, is the most important factor in a bird's life at this season.

BIRDS OF THE MONTH.

Permanent Residents, see page 85.
Winter Residents, see page 87.

February Bird-Life.—The conditions prevailing in the bird

world during January will be practically unchanged until the latter part of February. Then, should there be a period of mild weather, we may expect to hear the Song Sparrows and Bluebirds inaugurate the season of song. An unusually warm day earlier in the month may have tempted either or both of these birds prematurely to welcome spring, but as a rule we do not hear them until late in February, and then only under favorable conditions.

The songs of these birds bid us keep watch for the earlier migrants, the Robin, the Purple Grackle and the Red-winged Blackbird, birds which pass the winter such a short distance south of us that they appear at the first sign of returning spring. Further confidence in the growth of the new year is shown by the Great Horned Owl, one of our less common species, which begins nesting late in February or early in March.

In spite of these movements among the birds, February is, generally speaking, a winter month, and it is only in exceptional years that we find much change in our bird-life.

BIRDS OF THE MONTH.

Permanent Residents, see page 85.

Winter Residents, see page 87.

Migrants arriving from the South.

February 15 to 28, in favorable seasons.

Purple Grackle.	Red-winged Blackbird.
Rusty Blackbird.	Robin.

March Bird-Life.—Although March is sure to witness a general northward movement among the birds, the date of their arrival is as uncertain as the weather of the month itself. Continued severe weather prevents an advance, which a higher temperature occasions. It is well, therefore, to watch the weather predictions, since birds will quickly follow in the wake of a warm wave.

When the ice leaves our bays, ponds and rivers, Ducks and Geese will appear. Even before this event, the Grackles, Red-winged Blackbirds and Robins will come in flocks and in song, and singing will become general with the Song Sparrows and Bluebirds, whose numbers will be greatly increased. When successive thaws have rendered the earth soft enough for the Woodcock's probe, we may expect to find him in favorable localities searching for his fare of earthworms. With the advent of insects, we may look for their enemy the Phœbe, and Meadowlarks, Cowbirds and other March Migrants may be found.

The weather which hastens the arrival of birds from the

South, also prompts certain of our Winter Visitants to begin their northward journey, and after March we do not often see Redpolls, Snowflakes or Northern Shrikes.

BIRDS OF THE MONTH.

Permanent Residents, see page 85.

Winter Residents, see page 87.

Winter Residents leaving for the North.

Horned Lark. Snowflake.
Redpoll. Pine Grosbeak.
Northern Shrike.

Migrants arriving from the South.

Appearing when the ice leaves the bays and rivers.

Loon. Green-winged Teal.
Pintail. Blue-winged Teal.
Mallard. Canada Goose.

March 1 to 10.

Purple Grackle. Rusty Blackbird.
Red-winged Blackbird. Robin.

March 10 to 20.

Woodcock. Meadowlark.
Phœbe. Cowbird.
Fox Sparrow.

March 20 to 31.

Wilson's Snipe. Mourning Dove.
Kingfisher. Swamp Sparrow.
White-throated Sparrow.

April Bird-Life.—In early April the developments in the vegetable world, which the most casual observer cannot fail to see, are accompanied by corresponding but less noticed activities in the world of birds. The appearance of the skunk-cabbage, the blossoming of the pussy-willow and the early wild flowers soon become common knowledge; but the arrival of the Vesper, Field and Chipping Sparrows, of Tree Swallows, Myrtle Warblers and Hermit Thrushes, is known to comparatively few. Still, to the bird-lover, the return of these feathered friends is of even greater interest than the blossoming of trees and plants.

The migratory movement grows rapidly in strength, and during the latter part of the month one may expect to see newcomers almost daily. It will be noted that the earlier migrants of the month are all seed-eaters, while the later are certain insectivorous birds which catch their prey in the air, for example, Swallows, Swifts and Nighthawks.

BIRDS OF THE MONTH.

Permanent Residents, see page 85.

Winter Residents, see page 87.

Winter Residents leaving for the North.

Junco.	Brown Creeper.
Tree Sparrow.	Red-breasted Nuthatch.
Winter Wren.	Golden-crowned Kinglet.

Migrants arriving from the South.

April 1 to 10.

Pied-billed Grebe.	Field Sparrow.
Great Blue Heron.	Chipping Sparrow.
Black-crowned Night Heron.	Tree Swallow.
Osprey.	Myrtle Warbler.
Vesper Sparrow.	American Pipit.
Savanna Sparrow.	Hermit Thrush.

April 10 to 20.

American Bittern.	Barn Swallow.
Green Heron.	Yellow Palm Warbler.
Clapper Rail.	Pine Warbler.
Yellow-bellied Sapsucker.	Louisiana Water-Thrush.
Ruby-crowned Kinglet.	

April 20 to 30.

Spotted Sandpiper.	Purple Martin.
Semipalmated Sandpiper.	Cliff Swallow.
Whip-poor-will.	Bank Swallow.
Chimney Swift.	Rough-winged Swallow.
Least Flycatcher.	Black and White Warbler.
Towhee.	Black-throated Green Warbler.
Blue-headed Vireo.	Brown Thrasher.

May Bird-Life.—As the season advances, marked changes in temperature are less likely to occur, and the migration becomes regular and continuous. In February and March there may be two weeks or more variation in the times of arrival of the same species in different years; in May we expect to find a given species within a day or two of a certain date. We shall, nevertheless, find the force of the migratory current still closely dependent on the weather, and under the encouragement of a high temperature we may be visited by "bird waves," flooding the woods with migrants. Birds are then doubtless more abundant than at any other season. As many as ten species may be noted as arriving on the same day, and sixty or seventy species may be observed within a few hours.

After May 15, birds begin to decrease in number, the Transient Visitants passing farther north, and by June 5 we have only Permanent Residents and Summer Residents.

BIRDS OF THE MONTH.

Permanent Residents, see page 85.
Summer Residents, see page 86.

Migrants arriving from the South.

May 1 to 10.

Common Tern.
Solitary Sandpiper.
Semipalmated Plover.
Yellow-billed Cuckoo.
Black-billed Cuckoo.
Nighthawk.
Ruby-throated Hummingbird.
Crested Flycatcher.
Kingbird.
Baltimore Oriole.
Orchard Oriole.
Bobolink.
Grasshopper Sparrow.
Indigo Bunting.
Rose-breasted Grosbeak.
Scarlet Tanager.
Red-eyed Vireo.
Warbling Vireo.
Yellow-throated Vireo.
White-eyed Vireo.
Nashville Warbler.
Blue-winged Warbler.
Parula Warbler.
Black-throated Blue Warbler.
Magnolia Warbler.
Yellow-breasted Chat.
Chestnut-sided Warbler.
Prairie Warbler.
Small-billed Water-Thrush.
Hooded Warbler.
Yellow Warbler.
Maryland Yellowthroat.
Oven-bird.
Redstart.
House Wren.
Catbird.
Wood Thrush.
Veery.

May 10 to 20.

Wood Pewee.
Acadian Flycatcher.
Yellow-bellied Flycatcher.
White-crowned Sparrow.
Golden-winged Warbler.
Tennessee Warbler.
Worm-eating Warbler.
Cape May Warbler.
Blackburnian Warbler.
Bay-breasted Warbler.
Black-poll Warbler.
Wilson's Warbler.
Canadian Warbler.
Long-billed Marsh Wren.
Short-billed Marsh Wren.
Olive-backed Thrush.
Gray-cheeked Thrush.
Alder Flycatcher.
Mourning Warbler.
Bicknell's Thrush.

June Bird-Life.—After June 5 we may be reasonably sure that, with a few exceptions, every bird seen has or has had a nest in this vicinity. Several of the birds which began nesting in April will rear second broods in June, while the young of other April-nesting birds may not leave the nest until June. All the birds that began nesting in May will still be occupied with household affairs in June, and when we add to these the late-breeding species that wait for June before settling their domestic arrangements, it will be seen that among birds June is the home month of the year.

Nest-building, egg-laying, incubating and the care of the young now make constant and exceptional demands on birds which, in response, exhibit traits which at other times of the year they give no evidence of possessing. Singing now reaches its highest

development, and certain call-notes are heard only at this season. The numberless actions incident to courtship, the intelligence displayed in nest-building, the choice of special food for the young, the devotion which prompts the parents recklessly to expose themselves in protecting their offspring,—all these manifestations of the bird-mind may be observed in June.

BIRDS OF THE MONTH.

Permanent Residents, see page 85.
Summer Residents, see page 86.

July Bird-Life.—The full development of the bird year is attained in June, and as early as the first week in July the season begins to wane, when, among some migratory birds, there are evidences of preparation for the journey southward.

The young of certain species which rear but one brood a year have now left the nest, and, accompanied by the parents, wander about the country. In localities which we had thoroughly explored in June, we may now find species not met with then. In some cases these families join others of their kind, forming small flocks, the nuclei of the great gathering seen later. Examples are Grackles, Red-winged Blackbirds and Tree Swallows. The last named increase rapidly in number, and by July 10 we may see them flying over late each afternoon *en route* to their roosts in the Hackensack marshes.

During the first week in the month we shall also find that certain birds have concluded their season of song. Bobolinks and Red-winged Blackbirds are rarely heard after the 10th of the month; their young are reared, the cares of nesting-time are passed, and with other one-brooded birds they begin to renew their worn breeding plumages by molting. After the 15th we miss the voices of the Veery, Orchard and Baltimore Orioles, Chat, Brown Thrasher and other birds.

BIRDS OF THE MONTH.

Permanent Residents, see page 85.
Summer Residents, see page 86.

August Bird-Life.—With the majority of our nesting birds, family cares are ended in August, and at this season they completely renew their worn plumages by molting. When molting, birds are less in evidence than at any other time. What becomes of many of our birds in August it is difficult to say. Baltimore Orioles, for example, are rarely seen from August 1 to 20, but after the latter date they reappear clad in full plumage, and they are then in nearly full

song. So apparently complete is the disappearance of birds in August, that before the fall migration brings new arrivals daily from the north, one may spend hours in the woods and hear only the Red-eyed Vireo and the Wood Pewee, August's own songsters.

Late in the month, migrants from the north travel through the woods in small companies, but the characteristic bird-life of August is in the marshes. There the Swallows come in increasing numbers to their roosts in the reeds, while Red-winged Blackbirds and Bobolinks, under the alias of Reedbird, are abundant where the wild rice grows.

BIRDS OF THE MONTH.

Permanent Residents, see page 85.
Summer Residents, see page 86.
Migrants arriving from the North.

August 1 to 15.

Sora.
Semipalmated Sandpiper.
Semipalmated Plover.
Yellow-bellied Flycatcher.
Golden-winged Warbler.
Chestnut-sided Warbler.
Canadian Warbler.
Small-billed Water-Thrush.

August 15 to 31.

Olive-sided Flycatcher.
Tennessee Warbler.
Nashville Warbler.
Parula Warbler.
Cape May Warbler.
Black-throated Green Warbler.
Black-throated Blue Warbler.
Magnolia Warbler.
Blackburnian Warbler.
Wilson's Warbler.
Red-breasted Nuthatch.

September Bird-Life.—The student whose patience has been sorely tried by the comparative scarcity of birds in August will find that in September his observations in the field will be attended by far more interesting results. The first marked fall in the temperature is sure to be followed by a flight of migrants which, like the "bird waves" of May, will flood the woods with birds. By far the larger number will be Warblers; indeed, September, like May, is characterized by the abundance of these small birds.

Birds of the year will outnumber the adults, and in most cases their plumage will be quite unlike that worn by their parents in May. In many instances, even the adults themselves appear in a changed dress. As a rule, fall plumages are less striking than those of spring, and when, in addition, it is remembered that birds are not in song, and that the foliage is much denser, the greater difficulty of identifying birds in the field will be appreciated.

About September 25 our more common Winter Visitants arrive from the north, but afterward birds decrease rapidly in number.

BIRDS OF THE MONTH.

Permanent Residents, see page 85.

Summer Residents, see page 86.

Summer Residents leaving for the South.

September 1 to 10.

Acadian Flycatcher.
Orchard Oriole.
Rough-winged Swallow.
Worm-eating Warbler.
Blue-winged Warbler.

September 10 to 20.

Baltimore Oriole.
Purple Martin.
Yellow Warbler.
Yellow-breasted Chat.

September 20 to 30.

Common Tern.
Green Heron.
Hummingbird.
Kingbird.
Crested Flycatcher.
Wood Pewee.
Rose-breasted Grosbeak.
Yellow-throated Vireo.
Warbling Vireo.
Hooded Warbler.
Louisiana Water-Thrush.
Veery.

Migrants arriving from the North.

September 1 to 10.

Lincoln's Sparrow.
Black-poll Warbler.
Connecticut Warbler.

September 10 to 20.

Wilson's Snipe.
Blue-headed Vireo.
Olive-backed Thrush.
Bicknell's Thrush.

September 20 to 30.

Herring Gull.
Green-winged Teal.
Blue-winged Teal.
American Coot.
Junco.
White-throated Sparrow.
White-crowned Sparrow.
Myrtle Warbler.
Yellow Palm Warbler.
Brown Creeper.
Golden-crowned Kinglet.
Ruby-crowned Kinglet.
Winter Wren.
Gray-cheeked Thrush.

October Bird-Life.—Early October generally brings the first killing frost, depriving insectivorous birds of a large part of their food and forcing them to journey southward. Flycatchers, Warblers, Vireos and Swallows now take their departure, and after the 15th of the month few insect-eating birds remain, except those which, like Woodpeckers, feed on insect's eggs or larvæ.

This is the season of Sparrows. In countless numbers they throng old stubble, potato and corn fields, doing untold good by destroying the seeds of noxious weeds. With these birds will be the lately arrived Juncos, Tree Sparrows and Fox Sparrows. When disturbed, all seek shelter in the nearest hedgerow, and their mingled notes produce a twittering chorus in which it is difficult to distinguish the voices of individual birds.

This, however, will not be the only bird music of the month. Certain species now have a brief second song period, and on the brighter days of the month we may hear Song, White-throated and Fox Sparrows, Phœbes and Ruby-crowned Kinglets singing.

BIRDS OF THE MONTH.

Permanent Residents, see page 85.

Summer Residents, see page 86.

Summer Residents leaving for the South.

October 1 to 10.

Black-crowned Night Heron.
Yellow-billed Cuckoo.
Black-billed Cuckoo.
Chimney Swift.
Least Flycatcher.
Bobolink.
Grasshopper Sparrow.
Indigo Bunting.
Scarlet Tanager.
Cliff Swallow.
Barn Swallow.
Bank Swallow.
White-eyed Vireo.
Black and White Warbler.
Oven-bird.
Redstart.
Wood Thrush.

October 10 to 20.

Spotted Sandpiper.
Whip-poor-will.
Nighthawk.
Red-eyed Vireo.
Maryland Yellowthroat.
Catbird.
Brown Thrasher.
House Wren.
Short-billed Marsh Wren.
Long-billed Marsh Wren.

October 20 to 31.

Pied-billed Grebe.
Phœbe.
Towhee.
Tree Swallow.

Migrants arriving from the North.

October 1 to 10.

Loon.
Pintail.
Mallard.
Canada Goose.
Bronzed Grackle.
Rusty Blackbird.
American Pipit.
Hermit Thrush.

October 10 to 20.

Fox Sparrow.

October 20 to 31.

Horned Lark.
Pine Finch.
Tree Sparrow.
Snowflake.
Redpoll.
Northern Shrike.

November Bird-Life.—It is an interesting fact that the last migrants to leave in the fall are the first to arrive in the spring. The bird-life of November, when the fall migration is practically concluded closely resembles, therefore, that of March, when spring migration is inaugurated. The reason for this similarity is to be found in the fact that both months furnish birds with essentially the same kind of food. Thus the Loon, Grebes, Ducks, Geese and

Kingfisher remain until the forming of ice in November or early December deprives them of food and forces them to seek open water; while Woodcock and Snipe linger until they can no longer probe the frost-hardened earth. The thaws of March, however, will bring all these birds back to us by restoring their food. Certain Sparrows stay with us until the weed-bearing seeds on which they feed are covered by snow, when they are compelled to retreat farther southward, only to return, however, when the March sun lays bare the earth. Few birds' songs are heard in November. In some sheltered spot Song and White-throated Sparrows may continue in voice, but the characteristic bird-note of the month is the scatter-call or fall whistle of Bob-White.

BIRDS OF THE MONTH.

Permanent Residents, see page 85.

Migrants leaving for the South.

Wood Duck.
American Bittern.
Great Blue Heron.
Woodcock.
Mourning Dove.
Belted Kingfisher.
Cowbird.
Red-winged Blackbird.
Purple Grackle.
Vesper Sparrow.
Chipping Sparrow.
Field Sparrow.
Swamp Sparrow.

December Bird-Life.—The character of the bird-life of December depends largely upon the mildness or severity of the season. Should the ponds and streams remain open, the ground be unfrozen and little or no snow fall, many of the migrant species of November will linger into December.

The comparative scarcity of food now forces birds to forage actively for provisions, and when a supply is found, they are apt to remain until it is exhausted. Their wanderings in search of food lead them over large areas, and our dooryards and orchards may often be visited by species which, when food is more abundant, do not leave their woodland haunts. An excellent means of attracting them is to provide suitable food. Crumbs and seeds scattered in some place where they will not be covered by snow or blown away will bring Juncos and Tree Sparrows; an old seed-filled sunflower head may prove a feast for Goldfinches, while bits of meat, suet or ham bone hung from a tree will be eagerly welcomed by Chickadees, Nuthatches and Downy Woodpeckers.

BIRDS OF THE MONTH.

Permanent Residents, see page 85.

Winter Residents, see page 88.

List of Birds Found Within Fifty Miles of the American Museum of Natural History, New York City.[1]

Order PYGOPODES. Diving Birds.

Family COLYMBIDÆ. Grebes.

Holbœll's Grebe (*Colymbus Holbœlli*). A rather uncommon spring and fall migrant and less common winter resident.

Horned Grebe (*Colymbus auritus*). A common spring and fall migrant and not uncommon winter resident.

***Pied-billed Grebe; Diedapper; Dabchick; Hell Diver** (*Podilymbus podiceps*). Occurs chiefly as a migrant. In northern New Jersey and the Lower Hudson Valley it is common, but on Long Island is of "comparatively rare and infrequent occurrence" (Dutcher, MS). During favorable seasons a few pass the winter here. I know of no definite instance of its breeding. (See group, second floor of Museum).

Family GAVIIDÆ. Loons.

Loon (*Gavia imber*). A common migrant and less common winter resident. (See group, second floor).

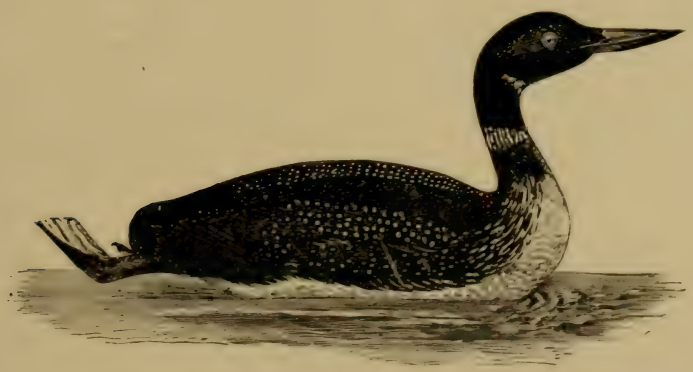

Fig. 1. Loon.

Black-throated Loon (*Gavia arctica*). Breeds in the far north, migrating southward to southern Canada. The only record of its occurrence near New York is based on an adult male (Coll. Am. Mus. No. 64,610) taken April 29, 1893, between Sands Point and Execution Lighthouse, L. I. (Dutcher, Auk, X, 1893, p. 265).

Red-throated Loon (*Gavia lumme*). A not uncommon winter resident, but more frequently found during the migrations.

[1] Issued also in separate form as **Guide Leaflet, No. 22.**

FAMILY ALCIDÆ. AUKS, MURRES AND PUFFINS.

Puffin (*Fratercula arctica*). There is but one recent record of its occurrence, December 15, 1882, Center Moriches, L. I. (Dutcher, Auk, V, 1888, p. 171).

Black Guillemot (*Cepphus grylle*). Breeds from the Bay of Fundy northward; in winter migrates southward, regularly to Massachusetts. It has been found but once in Connecticut (Stony Creek, Dec. 1887.—Sage, Auk, VII, 1890, p. 283), and the only Long Island record, given by Lawrence, is apparently based on a specimen in the Lawrence Collection labeled "Long Island" (Coll. Am. Mus. No. 64,614).

Brünnich's Murre (*Uria lomvia*). Breeds from the Magdalen Islands northward; in winter migrates southward as far as New Jersey. On the western end of Long Island it is as a rule uncommon; at the eastern end it occurs more frequently, but is irregular (Dutcher, Auk, II, 1885, p. 38). During some seasons, however, the bird becomes common in our waters (Averill, Auk, VIII, 1891, p. 307). Giraud's record of *"Uria troile"* doubtless refers to this species. Specimens in the Lawrence Collection originally labeled *"U. troile"* are *U. lomvia*. Records of the occurrence of this species on Long Island during the winter are given by Braislin (Auk, XX, 1903, p. 51).

Razor-billed Auk (*Alca torda*). Breeds from the Magdalen Islands northward; in winter migrates southward, regularly to Long Island and rarely to Virginia and North Carolina.

Dovekie (*Alle alle*). A species of the far north, migrating southward in winter, more or less regularly to New Jersey. With us its numbers vary during different winters. It is considered by Dutcher to be generally a rare bird on Long Island (Abst. Linn. Soc. No. 4, 1892, p. 6), but is given by Scott as a regular winter visitant on the New Jersey coast (Bull. Nutt. Orn. Club, IV, 1879, p. 228).

ORDER LONGIPENNES. LONG-WINGED SWIMMERS.

FAMILY STERCORARIIDÆ. SKUAS AND JÆGERS.

Pomarine Jæger (*Stercorarius pomarinus*). Passes the nesting season chiefly within the Arctic Circle and migrates southward from July to late October, during which period it is sometimes not uncommon off our coast, its presence depending largely on the abundance of the small fish on which it feeds (Baird, Auk, IV, 1887, p. 71).

Parasitic Jæger (*Stercorarius parasiticus*). Occurs off the coast in this vicinity as a regular migrant with the preceding species.

Long-tailed Jæger (*Stercorarius longicaudus*). During its migration it is sometimes not uncommon off our coast.

FAMILY LARIDÆ. GULLS AND TERNS.

Ivory Gull (*Pagophila alba*). A boreal species of which there appears to be but one record, that of an adult taken at Sayville, L. I., January 5, 1893 (Dutcher, Auk, XII, 1895, p. 290).

Kittiwake Gull (*Rissa tridactyla*). A common late fall transient visitant and a comparatively rare winter resident, occuring generally some distance off-shore (Dutcher, MS).

Glaucous Gull; Burgomaster (*Larus glaucus*). Several specimens have been killed on the Lower Hudson River, and off Long Island it is found regularly in small numbers (Dutcher, MS).

Iceland Gull (*Larus leucopterus*). A northern species of which but one valid record exists for this vicinity, Rye, N. Y. March 3, 1894 (Porter, Auk, XII, 1895, p. 76; see also Dwight, Auk, XXIII, 1906, p. 37, where a second specimen reported by Porter, and incorrectly recorded by Chapman as *leucopterus*, is given as *L. kumlieni*).

Kumlien Gull (*Larus kumlieni*). There are two records of this rare Gull for this vicinity, one is based on an immature male shot March 8, 1898, at Rockaway Beach, L. I. (Braislin, Auk, XVI, 1899, p. 190 and XXII, 1905, p. 168, where the specimen is definitely identified), the other an immature female taken February 16, 1894, at Stamford, Conn. (Porter, Auk, 1895, p. 76; see also Dwight, Auk, XXIII, 1906, p. 37, where this specimen incorrectly identified by Chapman is re-determined).

Great Black-backed Gull (*Larus marinus*). A regular winter resident not uncommon along the coast, but rarely ascending our rivers.

***Herring Gull** (*Larus argentatus*). This is the common winter Gull of our harbor and coast. It arrives from the north in September and is abundant until April. The adults are pearl gray; the immature birds, or young born the previous summer, are grayish brown. There has been an evident increase in the numbers of this species since certain of its breeding grounds have been protected. Braislin states that non-breeding birds are now common on the south shore of Long Island during the summer (Auk, XXII, 1905, p. 168).

Ring-billed Gull (*Larus delawarensis*). A rather uncommon spring and fall migrant and winter resident (Dutcher, MS). Braislin (Auk, XXII, 1905, p. 168) states that this species is not uncommon on Long Island in the summer, that it occurs in large numbers in October, but that he has no record later than November 17.

Laughing Gull (*Larus atricilla*). Formerly a common summer resident on Long Island, but now known to nest only on Great South Bay, where it is rare. (See group, second floor).

Bonaparte's Gull (*Larus philadelphia*). A regular spring and fall migrant, sometimes seen in winter.

Little Gull (*Larus minutus*). This is a European species; the only satisfactory records of its occurrence in North America are those of immature birds taken on Fire Island, Long Island, September 15, 1887 (Dutcher, Auk, V, 1888, p. 172), and Rockaway Beach, L. I., May 10, 1902 (Braislin, Auk, XX, 1903, p. 52).

Sabine's Gull (*Xema sabinii*). A circumpolar species breeding in the Far North and rarely coming as far south as northern United States. Giraud records a specimen shot at Raynor South, Long Island, "July, 1837."

Gull-billed Tern (*Gelochelidon nilotica*). A southern species breeding as far north as Virginia, and wandering occasionally to Maine. There are several Long Island records, the most recent being two specimens taken at South Oyster Bay, July 4, 1882 (Dutcher, Auk, I, 1884, p. 34), and one shot from a flock of five on Shinnecock Bay, July 8, 1884 (Dutcher, Auk, II, 1885, p. 38).

Caspian Tern (*Sterna caspia*). A rather uncommon fall migrant. There appears to be but one spring record, that of two adult males taken at Amityville, L. I., May 12, 1898 (Braislin, Auk, XVI, 1899, p. 191).

Royal Tern (*Sterna maxima*). There is but one instance of its occurrence on Long Island, a specimen taken at Raynor South, August 27, 1831, by J. F. Ward (Am. Mus. No. 46,008, Lawrence Coll.).

Forster's Tern (*Sterna Forsteri*). More common in the interior than on the Atlantic coast, where it is not known to breed north of Virginia. It wanders irregularly northward and is sometimes found in this vicinity.

Common Tern; Sea Swallow (*Sterna hirundo*). Inhabits the greater part of the Northern Hemisphere; in North America breeds locally from the Arctic regions to the Gulf of Mexico. This was formerly an abundant bird along our coasts, but the relentless persecutions of millinery collectors have so reduced its numbers that it is now found in only a few isolated localities. Not many years ago it bred more or less commonly all along the Long Island coast, but until recently almost the only surviving large colony inhabited Big Gull Island. Even in this remote locality it was constantly persecuted by nest-robbing fishermen and egg collectors. Through the efforts of a number of bird-lovers, who raised a sum of money for the purpose, permission was obtained from the Lighthouse Board to have the lightkeeper on Little Gull Island appointed a special game-keeper to protect the Terns on Big Gull Island. The birds rapidly increased under this guardianship, but the subsequent use, by the United States Government, of Gull Island for the erection of fortifications has caused the Terns to abandon it. Colonies are now found at both the northern and southern ends of Gardiner's Island.

Roseate Tern (*Sterna dougalli*). "Temperate and tropical regions." In north America formerly breeding along the Atlantic coast northward irregularly to Maine; now rare north of southern New Jersey. A few pairs lived on Big Gull Island with the colony of Common Terns above mentioned, but I have not observed the species in either of the Gardiner's Island colonies.

The Arctic Tern (*Sterna paradisæa*) is included by Lawrence without remark. I know of no record of its occurrence near New York City, and Mr. Dutcher has but one specimen from Long Island, a male taken on Ram Island Shoals, July 1, 1884.

Least Tern (*Sterna antillarum*). Formerly a common summer resident in suitable places on the coasts in this vicinity, but now occurs only as a rare migrant.

Sooty Tern (*Sterna fuliginosa*). A southern species, not breeding north of North Carolina, but occasionally straying farther up the coast. It has been recorded from Lake Ronkonkoma, L. I. (Dutcher, Auk, III, 1886, p. 433), and Highland Falls, N. Y. (Mearns, Bull. Essex. Inst. XII, 1879, 87).

Black Tern (*Hydrochelidon nigra surinamensis*). A species of the interior, breeding from Kansas and Illinois to Alaska. Occurs on the Atlantic coast as an irregular migrant, usually in the fall, sometimes in considerable numbers.

FIG. 2. TERN.

FAMILY RYNCHOPIDÆ. SKIMMERS.

Black Skimmer (*Rynchops nigra*). A southern species, not breeding north of Maryland, but occasionally wandering up the coast after the breeding season. There are several records of its occurrence on Long Island during the summer.

ORDER TUBINARES. TUBE-NOSED SWIMMERS.

FAMILY PROCELLARIIDÆ. FULMARS AND SHEARWATERS.

Fulmar (*Fulmarus glacialis*). An arctic species which sometimes wanders southward to Massachusetts. One was found in an exhausted condition at Ridgewood, New Jersey, December, 1892, after a storm (Hales, Orn. and Oöl., XVII, 1892, p. 39).

Cory's Shearwater (*Puffinus borealis*). A pelagic species, sometimes not uncommon off our coasts from August to November. It has been recorded from Amagansett (Dutcher, Auk, V, 1888, p. 5). to Cape Cod, Massachusetts, but doubtless occurs along our coast to the southward. Braislin records two specimens shot off Fire Island Inlet, October 4, 1902 (Auk, XXI, 1904, p. 287).

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Greater Shearwater (*Puffinus gravis*). A pelagic species, found on the Atlantic Ocean from Cape Horn to Greenland. Its breeding place is unknown. It appears off our coasts in early June and is irregularly common until November.

Audubon's Shearwater (*Puffinus Iherminieri*). A southern species, breeding in the Bahamas and Bermudas, and rarely wandering northward to Long Island (Dutcher, Auk, V, 1888, p. 173).

Sooty Shearwater (*Puffinus griseus*). Known from the North Atlantic southward to South Carolina. It is found off our coasts associated with the Greater Shearwater, but is much less common.

The Stormy Petrel (*Procellaria pelagica*) is included by Lawrence in his "Catalogue of Birds Observed on New York Island" etc., but the record is not accompanied by data, nor is there a specimen of the bird from this vicinity in the Lawrence Collection.

Leach's Petrel (*Oceanodroma leucorhoa*). Breeds from Maine northward, and in the winter ranges southward to Virginia. It is rather uncommon in this vicinity.

Wilson's Petrel (*Oceanites oceanicus*). Nests in the islands of the Southern Seas (Kerguelen Island) in January and February and migrates northward after the breeding season, reaching the waters of our coasts in May and remaining until late September. It sometimes enters the Lower Bay of New York harbor in numbers.

FIG. 3. PETREL.

ORDER STEGANOPODES. TOTIPALMATE SWIMMERS.

FAMILY SULIDÆ. GANNETS.

Booby (*Sula leucogaster*). Coasts and islands of tropical and sub-tropical America, north of Georgia. Accidental on Moriches Bay, L. I. (Dutcher, Auk, X, 1893, p. 270).

Gannet (*Sula bassana*). A spring and fall migrant, usually occurring well off shore.

Family PHALACROCORACIDÆ. Cormorants.

Cormorant (*Phalacrorcorax carbo*). It is not common south of Maine, and is rare in this vicinity.

Double-crested Cormorant (*Phalacrocorax auritus*). A common spring and fall migrant.

Family PELECANIDÆ. Pelicans

White Pelican (*Pelecanus erythrorhynchos*). Now rare or accidental on the Atlantic coast. Two specimens have been taken in this vicinity, one at Canarsie Bay, L. I. (Dutcher, Auk, X, 1893, p. 270), the other, a male, at Roslyn, May 11, 1885 (Forest and Stream, XXIV, 1885, p. 328).

Brown Pelican (*Pelecanus occidentalis*). Breeds as far north as South Carolina and occasionally strays up the coast as far as Massachusetts. DeKay records a specimen from Sandy Hook.

Order ANSERES. Lamellirostral Swimmers.

Family ANATIDÆ. Ducks, Geese and Swans.

American Merganser; Shelldrake (*Merganser americanus*). Not common from November to April.

Red-breasted Merganser; Shelldrake (*Merganser serrator*). On Long Island it is a very common spring and fall migrant (Dutcher, MS).

Hooded Merganser (*Lophodytes cucullatus*). A not common migrant and occasional winter visitant.

Mallard (*Anas boschas*). An irregular transient visitant, occurring in spring, winter and fall.

***Black Duck** (*Anas obscura*). Breeds from New Jersey to Labrador and winters from Massachusetts southward. It formerly nested in this vicinity, but now is found chiefly as a migrant, and less commonly in the winter. It still nests at some points on the Jersey coast and in a few localities on Long Island, (Dutcher, MS). (See group, second floor).

The Red-legged Black Duck, a supposed race of the Black Duck has been recorded from Long Island by Braislin (Auk, XXI, 288), but the status of this form is as yet too unsettled to make it desirable definitely to introduce it here.

Gadwall (*Chaulelasmus streperus*). A very rare migrant in this vicinity.

European Widgeon (*Mareca penelope*). An Old World species which occurs rarely on our coast. It has been taken at Leonia, N. J. (Chapman, Auk, VI, 1889, p. 302).

Baldpate; American Widgeon (*Marcca americana*). An irregular transient visitant.

European Green-winged Teal (*Nettion crecca*). An Old World species of rare occurrence on our coasts. It is recorded from Trenton, N. J. (Abbott, Geology of New Jersey, 1868, p. 792), Hartford, Conn. (Treat, Auk, VIII, 1891, p. 112), and from Merrick, L. I., where two specimens were captured in December, 1900 (Braislin, Auk, XIX, 1902, p. 145).

Green-winged Teal (*Nettion carolinensis*). A rather uncommon spring and fall migrant and winter resident.

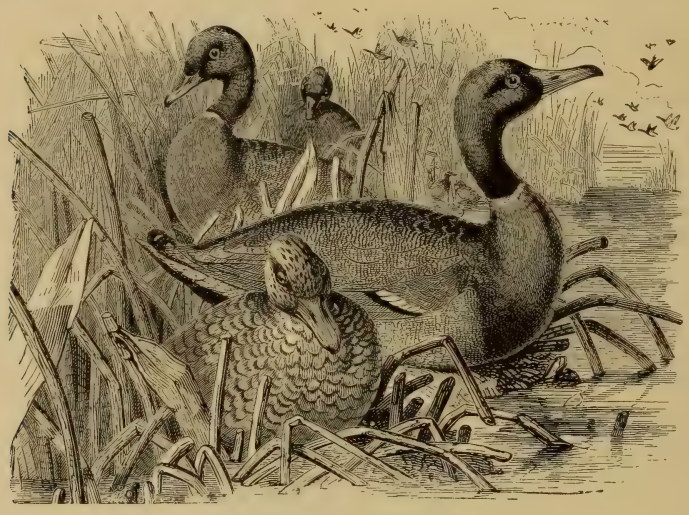

FIG. 4. MALLARDS.

Blue-winged Teal (*Querquedula discors*). A not common spring and common fall migrant.

Shoveller; Spoonbill (*Spatula clypeata*). A rare and irregular transient visitant.

Pintail; Sprigtail (*Dafila acuta*). A common migrant.

***Wood Duck; Summer Duck** (*Aix sponsa*). The Wood Duck is a rare summer resident on some of our more retired, wooded streams and becomes more common during the migrations.

The Rufous-crested Duck (*Netta rufina*) is an Old World species which is known as North American only from one specimen found in Fulton Market, New York City, and supposed to have been shot on Long Island.

Redhead (*Aythya americana*). On Long Island this species occurs as a regular migrant, in varying numbers, and is occasionally found in the winter (Dutcher, MS).

Canvasback (*Aythya vallisneria*). Occurs here as a not common migrant.

American Scaup Duck; Broad-bill; Blue-bill; Black-head; Raft Duck (*Aythya marila*). The commonest Duck of our bays, where it is sometimes seen in great numbers. It appears from the north about October 1 and remains until its feeding grounds are frozen over, returning as soon as the ice breaks in the early spring.

Lesser Scaup Duck; Little Blue-bill; Creek Broadbill; Raft Duck (*Aythya affinis*). Not as common as the preceding, with which its range in the main agrees.

Ring-necked Duck (*Aythya collaris*). North America, breeding only in the interior from Iowa northward. It is here a very rare, irregular transient visitant. The last record is that of Braislin (Auk, XVI, 1899, p. 191) who mentions a specimen from Great South Bay.

FIG. 5. CANVAS-BACK.

FIG. 6. REDHEAD.

American Golden-eye; Whistler (*Clangula clangula americana*). In favorable localities within our limits the Whistler is a not common migrant and winter resident.

Bufflehead; Butterball (*Charitonetta albeola*). A not uncommon migrant and winter resident.

Old-squaw; Old-wife; South-southerly (*Harelda hyemalis*). A common winter resident.

Harlequin Duck (*Histrionicus histrionicus*). Breeds from Newfoundland northward, and winters southward to New Jersey. A very rare winter visitant off our coast (Dutcher, Auk, III, 1886, p. 434; VI, 1889, p. 134).

The Labrador Duck (*Camptolaimus labradorius*), which formerly inhabited the Atlantic Coast, breeding from Labrador northward and wintering southward to New Jersey, is doubtless now extinct. The Labrador Duck was apparently once a not uncommon winter bird on Long Island. In a paper by William Dutcher (Auk, VIII, 1891, p. 201; see also Auk, XI, 1894, pp. 41, 175, 176.) summarizing our knowledge of its life-history and enumerating the extant specimens, Mr. George N. Lawrence is quoted as saying: "I recollect that about

forty or more years ago it was not unusual to see them in Fulton Market, and without doubt they were killed on Long Island; at one time I remember six fine males, which hung in the market until spoiled for want of a purchaser." Only forty-two of these Ducks have been recorded as existing in collections. Of this number seven are in the American Museum. (See group, second floor).

American Eider (*Somateria dresseri*). A rare winter visitant.

King Eider (*Somateria spectabilis*). Breeds from Labrador to the Arctic Regions, migrating southward regularly as far as eastern Long Island (Dutcher, Auk, V, 1888, p. 175).

American Scoter; Black Coot (*Oidemia americana*). A more or less common migrant and winter resident.

White-winged Scoter; White-winged Coot (*Oidemia deglandi*). A common migrant and winter visitant off our coasts.

Surf Scoter (*Oidemia perspicillata*). Found here with the preceding species.

Ruddy Duck (*Erismatura jamaicensis*). A not uncommon migrant, occurring in varying numbers.

Greater Snow Goose (*Chen hyperborea nivalis*). An irregular transient visitant.

FIG. 7. CANADA GOOSE.

American White-fronted Goose (*Anser. albifrons. gambeli*). North America, breeding far northward; in winter, south to Mexico and Cuba. Rare on the Atlantic Coast. It has been recorded on Long Island from Babylon (Giraud), Great South Bay Islip and Montauk (Dutcher, Auk, X, 1893, p. 271).

***Canada Goose** (*Branta canadensis*). A common migrant, appearing in November and remaining until our bays are frozen. In the spring the last birds pass on their northward journey as late as early May.

Hutchins's Goose (*Branta Canadensis hutchinsi*). A rare migrant in this vicinity.

White-bellied Brant (*Branta bernicla glaucogaster*). A common bird, appearing from the north in October and remaining until our bays are frozen, when it retreats farther southward. In April it returns, and the migration is not concluded until May.

Black Brant (*Branta nigricans*). This is a western species which is occasionally found on our coasts. It has been recorded from Egg Harbor, N. J. (Lawrence), Babylon and Islip, L. I. (Dutcher, Auk, 1893, pp. 266, 271).

Barnacle Goose (*Branta leucopsis*). An Old World species, occurring accidentally on our coasts. A specimen was killed on Jamaica Bay, L. I., in October, 1876 (Lawrence, Bull. Nutt. Orn. Club, II, 1877, p. 18).

Whistling Swan (*Olor Columbianus*). Breeds in the far north, and winters as far south as the Gulf of Mexico. It is an exceedingly rare bird on the Atlantic coast north of the Chesapeake. A recent record is that of a bird killed at Flatlands, L. I., within the limits of Greater New York, on Dec. 24, 1901. (Braislin, Auk, XX, 1903, p. 52).

Order HERODINES. Herons, Storks, Ibises, etc.

Family IBIDIDÆ. Ibises.

White Ibis (*Gura alba*). A bird of the Southern States, which has been recorded twice from this vicinity (Raynor South and Moriches, L. I., Giraud).

Glossy Ibis (*Plegadis autumnalis*). An Old World species of "irregular distribution in America." It has been recorded once from Southampton L. I., and once from Canarsie Bay, L. I. (Dutcher, Auk, X, 1893, p. 271).

Family ARDEIDÆ. Herons, Egrets, Bitterns, etc.

***American Bittern** (*Botaurus lentiginosus*). "Temperate North America, south to Guatemala and the West Indies"; breeds but rarely south of Virginia. In this vicinity it is not common during the summer.

Least Bittern (*Ardetta. exilis*). A locally common summer resident.

Great Blue Heron (*Ardea herodias*). With us it is a common migrant, and is probably found as a summer resident in a few localities. It is generally known by the name of "Crane."

American Egret (*Herodias egretta*). A southern species, breeding as far north as Virginia, and after the breeding season wandering northward in small numbers. It is here a rare and irregular summer visitant, occurring between August 1 and the last of September (Dutcher, Auk, X, 1884, p. 32). Comparatively recent records of the occurrence of this species are those of Braislin (Auk, XVII, 1900, p. 69; XIX, 1902, p. 145) and Owen (Auk, XV, 1898, p. 51).

Snowy Heron (*Egretta candidissima*). One of three individuals seen near Sayville, L. I., May 30, 1885, by William Dutcher and L. S. Foster was "carrying a long stick in its bill" (Dutcher, Auk, III, 1886, p. 435), and possibly was preparing to breed. Now an exceedingly rare bird breeding in a few isolated localities in Florida. Birds identified in life as this species are more apt to be the young of the Little Blue Heron (Braislin, Auk, XIX, 1902, p. 145).

Little Blue Heron (*Florida cærulea*). This southern species, like the preceding, wanders northward in small numbers after the breeding season, and a few are sometimes found near New York. (See group, second floor).

***Green Heron** (*Butorides virescens*). One of our commonest Herons and known under a great variety of names. It haunts the banks of streams and ponds and places its nest of sticks in a bush or the lower branch of a tree.

***Black-crowned Night Heron**; **Quawk** (*Nycticorax nycticorax nævius*). A locally common summer resident. There is a colony containing about 500 pairs not far from New York City. The popular name "Quawk," is derived from the call of the bird.

Yellow-crowned Night Heron (*Nyctanassa violacea*). Breeds from South Carolina southward and occasionally strays up the coast as far as Massachusetts. There is but one definite record for this region, that of a specimen taken in April, near Freeport, Queens County, L. I. (Dutcher, Auk, X, 1893, p. 286).

Order PALUDICOLÆ. Cranes, Rails, etc.

Family RALLIDÆ. Rails, Gallinules and Coots.

King Rail (*Rallus elegans*). Breeds as far north as Connecticut and has been known to stray to Maine. It is a rare summer resident of our fresh-water marshes (Dutcher, Auk, V, 1888, p. 176).

Clapper Rail; **Meadow Hen**; **Marsh Hen** (*Rallus crepitans*). This is an exceedingly common summer resident of the salt marshes of our coasts. Occasionally it winters in our region. (See group, second floor).

Virginia Rail (*Rallus virginianus*). A locally common summer resident, a few remaining during the winter.

Sora; **Carolina Rail**; **Rail-bird** (*Porzana carolina*). A rare summer resident in this vicinity, but in the fall it becomes common, feeding on wild rice of our marshes where, however, it is yearly becoming less numerous.

Yellow Rail (*Colurnicops noveboracensis*). Little is known about the nesting habits of this bird. It haunts grassy marshes and seeks safety by hiding or running, and for this reason is rarely seen. Several have been taken during the fall migration in this vicinity, and it is doubtless more common than is generally supposed. (See group, third floor.)

Black Rail (*Creciscus jamaicensis*). This bird, though much rarer, has as far as known the same habits as the preceding species and like it is very difficult to observe. It has been taken in the spring at Jamaica Bay and doubtless breeds in this vicinity, since its nest has been found at Saybrook, Conn. (Clarke, Auk, I, 1884, p. 394). (See group, third floor).

Corn Crake (*Crex crex*). This is an Old World species which sometimes strays to Greenland and our Atlantic coast. In this region there are records for Sag Harbor, L. I. (Dutcher, Auk, III, 1886, p. 435), Oakdale, L. I. (Dutcher, Auk, V, 1888, p. 177), and Saybrook, Conn. (Clark, Orn. and Oöl., XIII, 1888, p 45).

Purple Gallinule (*Ionornis martinica*). Tropical America, breeding as far north as South Carolina, and straying casually to Maine. There are but two definite records for this region, Middle Island, L. I. (Helme, Orn. and Oöl., VII, 1882, p. 118) and Indian Pond, near Flatlands, L. I. (Dutcher, Auk, X, 1893, p. 272).

Florida Gallinule (*Gallinula galeata*). Temperate and tropical America, breedng as far north as Maine, and wintering from Florida southward. It breeds only locally in the northeastern part of its range, frequenting the borders of ponds or streams surrounded by marshy grounds. Its nest has not been found in the immediate vicinity of New York City, where it is known only as a rare migrant.

***Coot**; **Mud-hen**; **Crow-duck** (*Fulica americana*). The Mud-hen is a not uncommon bird during migration, but it is recorded as breeding only near Morristown, N. J. (Thurber, True Democratic Banner, newspaper, Nov. 10, 1887).

Order LIMOCOLÆ. Shore Birds.

Family PHALAROPODIDÆ. Phalaropes.

Red Phalarope (*Crymophilus fulicarius*). The Phalaropes are pelagic birds, not often coming to our coasts unless driven shoreward by storms. There are both August and May records for this species on Long Island.

Northern Phalarope (*Phalaropus lobatus*). This bird occurs with us as a regular migrant, and after severe storms it is sometimes common in flocks. (Dutcher, Auk, 1884, p. 33).

Wilson's Phalarope (*Steganopus tricolor*). Interior of North America, breeding from northern Illinois northward. With us it is a very rare and irregular migrant.

FAMILY RECURVIROSTRIDÆ. AVOCETS AND STILTS.

American Avocet (*Recurvirostra americana*). A bird of the interior, breeding from Texas to the Saskatchewan. Giraud mentions it as casual on Long Island, and says that a few bred at Egg Harbor, N. J. (Dutcher records four individuals seen by Col. Nicholas Pike on Long Island as follows: Ponquogue, 1844; Canarsie Bay, 1847; Southampton, two, no date (Auk, X, 1893, p. 272).

Black-necked Stilt (*Himantopus mexicanus*). A southern species, breeding in the Gulf States and locally in the Mississippi Valley and westward; rare on the North Atlantic coast. Giraud mentions it as "unfrequent," and Dutcher records two specimens taken by Colonel Pike on Great South Bay, one of them in 1843 (Auk, X, 1893, p. 272).

FAMILY SCOLOPACIDÆ. SNIPES, SANDPIPERS, ETC.

European Woodcock (*Scolopax rusticola*). The only record for the occurrence of this species in this vicinity is based on a specimen found in Washington Market, December 6, 1859, which was said to have been killed near Shrewsbury, N. J. (Lawrence, Ann. Lyc. Nat. Hist., VIII, 1866, p. 223).

***Woodcock** (*Philohela minor*). The woodcock is a not uncommon summer resident and more numerous fall migrant. Owing to the clearing of timber areas, draining of lands and demands of sportsmen, it is however, yearly decreasing in numbers in the vicinity of New York. It arrives early in March, and does not leave us until the ground is frozen. (See group, second floor).

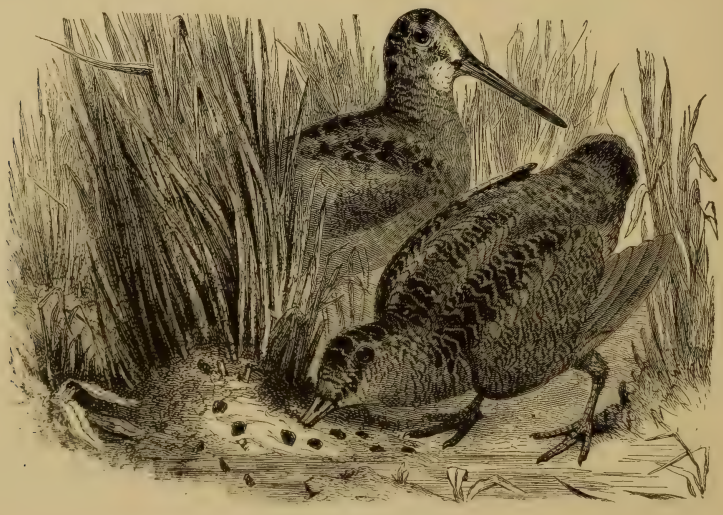

FIG. 8. WOODCOCK.

Wilson's Snipe; English Snipe (*Gallinago delicata*). A not uncommon migrant, and crippled birds are said to have nested on several occasions near Chatham, N. J. (Herrick, Forest and Stream, XII, 1879, p. 165). During mild seasons a few pass the winter here (Dutcher, MS).

Dowitcher (*Macrorhamphus griseus*). A common migrant, arriving from the south about May 1 and returning from the north between July 10 and August 15.

Migrating Snipe, Sandpipers and Plovers fly, as a rule, some distance off the land and if the weather is calm and clear, very few birds are found on our shores. If, however, during their migrations storms from the right quarter, or fogs occur, many birds are driven shoreward and there results what among sportsmen is known as a "flight."

Long-billed Dowitcher (*Macrorhamphus scolopaceus*). This western representative of our common Dowitcher is a rare but regular late fall migrant along the Atlantic coast.

Stilt Sandpiper (*Micropalama himantopus*). A not common but by no means rare migrant, occurring chiefly during the fall migration from the middle of July to the middle of September.

Knot; Robin Snipe (*Tringa canutus*). A common migrant, passing northward during May and returning from the middle of July to the first of October.

Purple Sandpiper (*Arquatella maritima*). A rare but regular winter resident.

Pectoral Sandpiper; Krieker (*Actodromas maculata*). A common and sometimes abundant fall migrant in this vicinity; less frequently seen in the spring. It returns from the north in early August, and its migration is concluded about the last of October.

White-rumped Sandpiper (*Actodromas fuscicollis*). A not uncommon spring and fall migrant.

Baird's Sandpiper (*Actodromas bairdi*). Casual on the Atlantic coast. There are several records for this vicinity, as follows: Rockaway, L. I., August, two specimens, and September, two specimens (N. T. Lawrence, Forest and Stream, X, 1878, p. 235), and Far Rockaway, L. I., August, one specimen (N. T. Lawrence, Auk, II, 1885, p. 273).

Least Sandpiper; Peep; Meadow Oxeye (*Actodromas minutilla*). This is one of our commonest Sandpipers, and shares the names "Peep" or "Oxeye" with the Semipalmated Sandpiper. It is seen in small flocks running along our shores and beaches. It passes northward during May and returns about July 10, the fall migration being concluded about September 1.

Red-backed Sandpiper; Lead-back (*Pelidna alpina sakhalina*). A very common migrant on our coasts, less common in the spring than in the fall. It migrates northward in early May and returns about September 1, remaining until November.

Curlew Sandpiper (*Erolia ferruginea*). "Old World in general, occasional in eastern North America." There are several records of its occurrence on Long Island.

Semipalmated Sandpiper; Peep; Sand Oxeye (*Ereunetes pusillus*). This is our most common Sandpiper, and during its fall migration it is abundant along our shores in small flocks. It migrates northward during May, returns about July 10, and the fall migration is not concluded until about October 1.

Western Sandpiper (*Ereunetes mauri*). This is the western representative of the preceding species. It is not infrequently found on our coast, generally associated with *E. pusillus*. Braislin (Auk, XVI, 1899, p. 191) records it as abundant on Long Island in the fall of 1897.

Sanderling; Surf Snipe (*Calidris alba*). An abundant migrant along our coasts, where, as a rule, it is found on the outer beaches. It passes northward during May and returns on its southward journey about July 10, from which date until October it is more or less numerous.

Marbled Godwit; Brown Marlin (*Limosa fedoa*). This is a rare bird on the Atlantic coast, where it occurs only as an irregular fall visitant.

Hudsonian Godwit; Ring-tailed Marlin (*Limosa hæmastica*). In this vicinity the Ring-tailed Marlin is an irregular fall migrant (Dutcher, Auk, III, 1889, p. 437). Kobbe (Auk, XXI, 1904, p. 79) records a flight of this species as occurring at Quogue, L. I., August 31, 1903.

***Greater Yellow-legs** (*Totanus melanoleucus*). A common migrant, arriving in the spring about the latter half of April and returning in the latter half of July, the migration not being concluded until November.

Yellow-legs; Summer Yellow-legs (*Totanus flavipes*). Very rare in the spring, but abundant during its southward migration, which begins about July 15 and ends in September.

***Solitary Sandpiper** (*Helodromas solitarius*). A not uncommon migrant passing northward in May and returning in July. It is not a true Shore-bird, but is more frequently found near fresh-water ponds and streams.

Willet (*Catoptrophorus semipalmatus*). In this vicinity it occurs only as a rare fall migrant. It is probable that the Western Willet (*C. s. inornata*) is also occasionally found on our coasts.

Ruff (*Pavoncella pugnax*). "Northern parts of the Old World, straying occasionally to eastern North America." There are three specimens of this bird in the American Museum from North America, two of which, in the Lawrence Collection, are labeled "Long Island," while the third is in the Elliot Collection and is labeled "Barnegat, N. J." (For record of the occurrence of this species in America, see Deane, Auk, XXII, 1905, p. 411; and Palmer, Auk, XXIII, 1906, p. 99.)

Bartramian Sandpiper; Upland Plover; Field Plover (*Bartramia longicauda*). A rather rare migrant and still rarer summer resident. It arrives about the middle of April and frequents fields and pastures.

Buff-breasted Sandpiper (*Tryngites subruficollis*). A bird of the interior, breeding in the far north and wintering in South America. It is very rare on the Atlantic coast. Giraud records "a party of five" as seen in August and September (N. T. Lawrence, Forest and Stream, X, 1879, p. 235); one was taken in August at Montauk Point (Berier, Bull, N. O. C., VI, 1880, p. 126); Dutcher mentions an August specimen from Suffolk County and a midsummer bird from Shinnecock Bay (Auk, VI, 1889, p. 136); and Braislin records a male taken August 30, 1903 at Rockaway Beach (Auk, XXII, 1905, p. 169).

***Spotted Sandpiper; Tip-up** (*Actitis macularia*). This is the common Sandpiper so frequently seen on our ponds, streams and beaches, and is one of the few members of this family which breeds here. It arrives about April 25 and remains until October.

Long-billed Curlew; Sickle-bill (*Numenius longirostris*). A rare and irregular fall visitant.

Hudsonian Curlew; Jack Curlew (*Numenius hudsonicus*). The Jack Curlew, as it is locally known, is a not uncommon migrant in this vicinity. It passes northward in May, and the southern migration occurs between the middle of July and the first of October.

Eskimo Curlew; Dough-bird; Fute (*Numenius borealis*). This species has decreased in numbers during recent years and is believed by some ornithologists to be on the verge of extinction. There is but one record of its recent occurrence, that of a male shot by R. L. Peavey at Rockaway Beach, L. I., September 14, 1902 (Braislin, Auk, XXI, 1904, p. 289).

FAMILY CHARADRIIDÆ. PLOVERS.

Lapwing (*Vanellus vanellus*). An Old World species, of accidental occurrence in America. The only record for eastern North America south of Greenland is that of a specimen shot at Merrick, L. I., December, 1883, (Dutcher, Auk, III, 1886, p. 438).

Black-bellied Plover; Beetle-head (*Squatarola squatarola*). A common migrant, more numerous in the fall. It passes northward from about April 15 to June 1, and the return migration occurs between August 1 and November 1.

Golden Plover; Green-back (*Charadrius dominicus*). A rare spring and common fall migrant, occurring chiefly in September.

Killdeer (*Oxyechus vociferus*). In the neighborhood of New York City the Killdeer is a rare summer resident and not uncommon migrant. It arrives in March and remains with us until November.

Semipalmated Plover; Ring-neck (*Ægialitis semipalmata*). The Ring-neck is one of our most common shore-birds. It passes northward in May and returns about July 15, the fall migration not being concluded until October 1.

Piping Plover (*Ægialitis meloda*). It is here a rare local summer resident and more common migrant, arriving in April and remaining until September.

Wilson's Plover (*Ochthodromus wilsonius*). Breeds as far north as Virginia, and strays casually to Nova Scotia. There are several records for Long Island (Dutcher, Bull. N. O. C., IV, 1879, p. 242; Auk, III, 1886, p. 438, Shinnecock Bay), and one for Bridgeport, Conn. (Averill, List of Birds found in the vicinity of Bridgeport, 1892, p. 9).

FAMILY APHRIZIDÆ. SURF BIRDS AND TURNSTONES.

Turnstone; Brant-bird; Calico-back (*Arenaria morinella*). With us it is a common migrant passing northward in May, returning about August 1 and remaining until September.

FAMILY HÆMATOPODIDÆ. OYSTER-CATCHERS.

Oyster-catcher (*Hæmatopus pallitus*). Breeds as far north as Virginia and occasionally strays to Nova Scotia. It is here of rare and irregular occurrence (Dutcher, Auk, X, 1893, p. 272).

ORDER GALLINÆ. GALLINACEOUS BIRDS.

FAMILY TETRAONIDÆ. GROUSE, PARTRIDGES, ETC.

***Bob-white; Quail** (*Colinus virginianus*). Quail are not uncommon in the vicinity of New York, but they are so eagerly hunted, that, as the country becomes more thickly settled, only the most rigid enforcement of the game-laws will preserve them from extermination. Recent severe winters have greatly decreased the numbers of this species, virtually exterminating it in some localities, and were it not for the liberation of southern birds by sportsmen, it is probable that the species would be exceedingly rare if not indeed extinct throughout most of the region surrounding New York City. (See group, second floor).

***Ruffed Grouse; Partridge** (*Bonasa umbellus*). Partridges are much less common with us than Quails. They are birds of the woods, and for this reason disappear with the forests, while Quails, on the contrary become more numerous as the country is cleared. (See group, second floor).

In the early part of the nineteenth century Pinnated Grouse or Heath Hens (*Tympanuchus cupido*) were abundant in some parts of Long Island, but they have been extinct for about sixty years (Giraud, Birds of Long Island, p. 195, and Dutcher, Auk, X, 1893, p. 272). As late as 1860 odd this species occurred in numbers on the Plains of the Jersey Pine Barrens west of Barnegat, where it was exterminated by indiscrimate shooting at all seasons (Chapman, Bird-Lore, V, 1903, p. 50).

The Wild Turkey (*Meleagris gallopavo silvestris*) is still found in small numbers in the wilder, more mountainous portions of Pennsylvania, but has

long been extinct in this vicinity. De Kay (Zoölogy of New York, II, Birds, 1844, p. 200) writes that he had not met with the species in New York State, but was informed at the time he wrote it was found in the counties of Sullivan, Rockland, Orange, Alleghany and Cattaraugus. This species is not mentioned by either Giraud or Lawrence.

Order COLUMBÆ. Pigeons.

Family COLUMBIDÆ. Doves and Pigeons.

Passenger Pigeon; Wild Pigeon (*Ectopistes migratorius*). Fifty years ago the Wild Pigeon was an abundant bird in the vicinity of New York, but here, as elsewhere throughout its range, it has become very rare. In place of the thousands that used to visit us it is now observed irregularly and rarely. (Lawrence, Auk, VI, 1889, p. 196, and Dutcher, Auk, X, 1893, p. 274). There appears to be but one definite record since 1894 of the occurrence of the Wild Pigeon near New York, that of an immature male shot at Englewood, N. J., June 23, 1896, by C. I. Wood (Chapman, Auk, XIII, 1896, p. 341).

***Mourning Dove** (*Zenaidura macroura*). A common summer resident, under favorable circumstances passing the winter.

Ground Dove (*Columbigallina passerina terrestris*). This is a species of the South Atlantic and Gulf States. It has been once taken in this vicinity (Grinnell, Bull. N. O. C., III, 1878, p. 147), but its occurrence is purely accidental, and it is possible that the specimen captured was an escaped cage-bird.

Order RAPTORES. Birds of Prey.

Family CATHARTIDÆ. American Vultures.

Turkey Vulture; Turkey Buzzard (*Cathartes aura septentrionalis*). Of more or less regular occurrence in New Jersey as far north as Plainfield in the interior and Sandy Hook on the coast. It is also occasionally seen on Long Island. One record notes the occurrence of a flock of eight birds of this species in Orange County, N. Y. (Reynolds, Forest and Stream, XVIII, 1894, p. 181).

Black Vulture (*Catharista urubu*). Breeds from North Carolina southward, and occasionally strays as far north as Maine. There are records for Sandy Hook, N. J. (Robt. B. Lawrence, Bull. N. O. C., V, 1880, p. 116), and Coney Island, L. I. (Berier, Bull. N. O. C., VI, 1881, p. 126).

Family FALCONIDÆ. Falcons, Hawks, Eagles, etc.

Swallow-tailed Kite (*Elanoides forficatus*). In this vicinity it has been recorded from Raynor South, L. I. (Giraud, Birds of Long Island, p. 13), "South shore of Long Island" (Berier, Bull, N. O. C., VI., 1881, p. 126), Chatham, N. J. (Herrick, Forest and Stream, XII, 1879, p. 165), and Piermont, N. Y. (Nicholas, Auk, XVII, 1900, p. 386).

***Marsh Hawk** (*Circus hudsonius*). A permanent resident, common except during the winter.

***Sharp-shinned Hawk** (*Accipiter velox*). It is here an uncommon summer and rare winter resident.

***Cooper's Hawk** (*Accipiter cooperi*). With us a not uncommon summer and rare winter resident. This bird, the Sharp-shinned Hawk and the rare Duck Hawk and Goshawk, are the only species of our Hawks which habitually live on birds. The others feed largely on insects and small field-mice, and being thus actually beneficial, should be protected by law.

Goshawk (*Astur atricapillus*). A rare winter visitant.

***Red-tailed Hawk** (*Buteo borealis*). The Red-tail is one of our commonest Hawks and is resident throughout the year.

***Red-shouldered Hawk** (*Buteo lineatus*). A permanent resident. It is probably our most common Hawk and with the Red-tail is the one to which the name "Chicken," or "Hen Hawk," is generally, but incorrectly, applied.

Swaison's Hawk (*Buteo swainsoni*). A western species of rare occurrence on the Atlantic coast. There is apparently but one record of its capture near New York City, that of a specimen shot near Cornwall, N. Y., October 14, 1892 (Dutcher, Auk, X, p. 83).

***Broad-winged Hawk** (*Buteo platypterus*). A rather uncommon summer resident.

Rough-legged Hawk (*Archibuteo lagopus sancti-johannis*). A rare winter resident.

Golden Eagle (*Aquila chrysaetos*). North America, of rare occurrence east of the Mississippi. It has been recorded from Islip, L. I. (Giraud), Canarsie, L. I. (Dutcher), Gravesend, L. I. (Johnson), Long Branch, N. J. (Chapman, Auk, XV, 1898, p. 54), and Highland Falls, N. Y. where Mearns states, it is occasionally observed and was formerly known to nest.

***Bald Eagle** (*Haliætus leucocephalus*). This Eagle is here a rather rare bird; it is said by Mearns to nest in the Highlands of the Hudson. On Long Island it is a not uncommon resident and breeds in several localities (Dutcher MS).

Gyrfalcon (*Falco rusticolus gyrfalco*). An arctic species, rarely visiting the United States. The only record for this vicinity is that of a specimen killed on Long Island in the winter of 1856 (Lawrence, Ann. Lyc. Nat. Hist., New York, VIII, 1866, p. 280; see also Brewster, Auk, XII, 1895, p. 180).

Black Gyrfalcon (*Falco rusticolus obsoletus*). "Labrador, south in the winter to Maine and New York." There is but one record of its occurrence in this vicinity, viz., a specimen shot in the fall of 1875, near Flushing, L. I. (Berier, Bull. N. O. C., VI, 1881, pp. 126, 247).

Duck Hawk (*Falco peregrinus anatum*). This Falcon, the "noble Peregrine" of Falconry, is a not uncommon migrant, especially along our coast, and is a rare summer resident along the Palisades and Highlands of the Hudson, where it is known to breed. (See group, second floor).

DUCK HAWK

Group, Hall No. 234

Pigeon Hawk (*Falco columbarius*). A common migrant, occurring chiefly on our coasts.

American Sparrow Hawk (*Falco sparverius*). With us it is a not common resident but abundant migrant along the coasts.

American Osprey; Fish Hawk(*Pandion haliætus carolinensis*). A locally abundant summer resident arriving early in April and remaining until October. At certain localities along our coasts, the Fish Hawk is found nesting in colonies.

FIG. 9. AMERICAN OSPREY.

FAMILY STRIGIDÆ. BARN OWLS.

American Barn Owl (*Strix pratincola*). Occasionally found as far north as Massachusetts, and breeds from Long Island southward through Mexico. The Barn Owl is here a rare permanent resident. There are numerous records of its nesting, and it appears to have increased in numbers during recent years.

FAMILY BUBONIDÆ. HORNED OWLS, ETC.

***American Long-eared Owl** (*Asio wilsonianus*). A rather uncommon resident.

Short-eared Owl (*Asio accipitrinus*). Common during the migrations, and while a few probably breed, their is no definite record of their doing so.

***Barred Owl** (*Syrnium varium*). Next to the Screech Owl this is our commonest Owl. Its loud, sonorous hooting, *whoo, whoo, whoo, too-whoo, too whoo-ah,* is heard in the spring and again in late summer and is familiar to many who are not acquainted with its author.

FIG. 10. SHORT-EARED OWL.

Great Gray Owl (*Scotiaptex nebulosa*). In winter to the northern border of the United States. An individual shot near Mendham, N. J., is the only one which has been recorded from near New York City (Thurber, True Democratic Banner, newspaper, Morristown, N. J., Nov. 10, 1887).

***Saw-whet Owl** (*Crytoglaux acadica*). A regular and, in some localities, a not uncommon winter resident.

Screech Owl (*Megascops asio*). The Screech Owl is the commonest and best known of our Owls. It is present throughout the year. (See group, second floor).

SCREECH OWL
Group, Hall No. 208

Great Horned Owl (*Bubo virginianus*). A rather rare resident. This is the only one of our Owls which habitually preys upon poultry, the others feed largely on field-mice and shrews.

***Snowy Owl** (*Nyctea nyctea*). An irregular winter visitant, sometimes occurring in considerable numbers.

Hawk Owl (*Surnia ulula caparoch*). There is apparently but one record of its capture in this vicinity, that of a specimen shot near Bay Ridge, L. I. (Dutcher Auk, X, 1893, p. 275).

Order COCCYGES. Cuckoos, etc.

Family CUCULIDÆ. Cuckoos, Anis, etc.

***Yellow-billed Cuckoo** (*Coccyzus americanus*). A common summer resident, arriving about May 10 and departing the last of September. (See group, third floor).

***Black-billed Cuckoo** (*Coccyzus erythrophthalmus*). A common summer resident arriving and departing at about the same time as the preceding species.

Family ALCEDINIDÆ. Kingfishers

***Belted Kingfisher** (*Ceryle alcyon*). A common summer resident, arriving the latter part of March and remaining until the streams and ponds, from which it obtains its food, are frozen.

Order PICI. Woodpeckers.

Family ALCEDINIDÆ. Kingfishers.

***Hairy Woodpecker** (*Dryobates villosus*). A rather uncommon resident.

***Downy Woodpecker** (*Dryobates pubescens medianus*) next to the Flicker, the Downy is our commonest Woodpecker .

Red-cockaded Woodpecker (*Dryobates borealis*). Southern United States, westward to Indian Territory, and northward to Tennessee and Virginia. This bird is accidental near New York, the only record of its occurrence being based on a specimen taken at Hoboken, N. J. (Lawrence, Ann. Lyc. Nat. Hist., VIII, 1866, p. 291).

***Yellow-bellied Woodpecker** (*Sphyrapicus varius*). A common spring and fall migrant.

Pileated Woodpecker (*Ceophlœus pileatus abieticola*). "Formerly whole wooded region of North America; now rare or extirpated in the more thickly settled parts of the Eastern States." This large Woodpecker occurs near New York only as a very rare straggler; there are no recent records.

FIG. 11. RED-HEADED WOODPECKER.

***Red-headed Woodpecker** (*Melanerpes erythrocephalus*). A summer resident of local distribution and a not uncommon and sometimes abundant migrant. Occasionally it is found in winter.

Red-bellied Woodpecker (*Centurus carolinus*). Eastern United States breeding from Florida to Virginia, and in the interior, to Ontario and Southern Dakota; occasionally strays to Massachusetts; winters from southern Ohio southward. Giraud speaks of this bird as breeding on Long Island, but it now occurs here only rarely and irregularly.

***Flicker: High-hole; Clape** (*Colaptes auratus luteus*). Our commonest Woodpecker. It is resident, but is much more common in the summer than in the winter, and is particularly numerous during its migrations in September and October.

ORDER MACROCHRIES. GOATSUCKERS, SWIFTS, ETC.

FAMILY CAPRIMULGIDÆ. GOATSUCKERS.

FIG. 12. NIGHTHAWK.

***Whip-poor-will** (*Antrostomus vociferus*). In some localities near New York City the Whip-poor-will is a common summer resident. It arrives about May 1 and leaves about October 1.

***Nighthawk** (*Chordeiles virginianus*). The Nighthawk is here a more or less common local summer resident. Even in New York City, where it has been known to lay eggs on the house-top, its characteristic note, *peent, peent,* uttered while it is coursing for food, is not infrequently heard. It arrives early in May and migrates southward in September and October, sometimes occurring at this season in large flocks.

FAMILY MICROPODIDÆ. SWIFTS.

***Chimney Swift** (*Chætura pelagica*). An abundant summer resident, arriving the latter part of April and remaining until October. (See group, second floor).

FAMILY TROCHILIDÆ. HUMMINGBIRDS.

***Ruby-throated Hummingbird** (*Trochilus colubris*). This, the only species of Hummingbird found in eastern North America, is here a common summer resident, arriving early in May and remaining until October.

FIG. 13. RUBY-THROATED HUMMINGBIRDS AND NEST.

ORDER PASSERES. PERCHING BIRDS.

FAMILY TYRANNIDÆ. TYRANT FLYCATCHERS.

***Kingbird** (*Tyrannus tyrannus*). A common summer resident, arriving early in May and remaining until October. (See group, third floor).

Arkansas Kingbird (*Tyrannus verticalis*). A western species; the only records for this vicinity are those of a young male taken at Riverdale, N. Y., October 19, 1875, (Bicknell, Bull, N. O. C., IV, 1879, p. 60), and a specimen taken at Princeton, N. J., Sept. 29, 1894 (Phillips, Proc. D. V. O. C., II, p. 14).

***Great-crested Flycatcher** (*Myiarchus crinitus*). A common summer resident, arriving early in May and remaining until September.

***Phœbe** (*Sayornis phœbe*). A common summer resident arriving about March 20 and leaving early in November.

***Olive-sided Flycatcher** (*Nuttalornis borealis*). A migrant passing north in May, when it is apparently rare, and returning between the latter part of August and late September, when it is not uncommon.

***Wood Pewee** (*Horizopus virens*). A common summer resident of our woods, arriving about May 15 and remaining until the latter part of September.

***Yellow-bellied Flycatcher** (*Empidonax flaviventris*). A rather rare spring and not uncommon fall migrant, arriving in May and returning from its northern home early in August.

***Green-crested Flycatcher** (*Empidonax virescens*). A common summer resident of the Lower Hudson River Valley as far north as Sing Sing. On Long Island it apparently breeds on the north shore, while there are but two records for Connecticut, an adult taken at Suffield, June 24, 1874 (Merriam, Birds, Conn., p. 58) and a nest with young at Greenwich, June 25, 1893 (Voorhees, Auk, XI, 1894, p. 259). A rare summer resident in the vicinity of Plainfield, N. J. (Miller, MS). (See group, third floor).

Alder Flycatcher (*Empidonax trailli alnorum*). A rather rare migrant and a local summer resident. A nest and eggs, not fully identified, but with little doubt that of this species, was found by C. L. Brownell at Nyack, N. Y. At Plainfield, N. J., W. DeWitt Miller has found this species a locally common breeding bird (Auk, XVIII, 1901, p. 108; XX, 1903, p. 68).

***Least Flycatcher** (*Empidonax minimus*). A common summer resident; it arrives about May 1 and remains until late in September.

Family ALAUDIDÆ. Larks.

Skylark (*Alauda arvensis*). Individuals of this species have from time to time been liberated near New York City. In 1887 a small colony became established near Flatbush, L. I., where a nest containing young was found (Dutcher, Auk, V, 1888, p. 180). Without apparent increase these birds evidently manage to hold their own (Braislin, Auk, XVI, 1899, p. 191; Bildersee, Bird-Lore, VI, 1904, p. 204).

Fig. 14. Horned Lark.

Horned Lark; Shore Lark (*Otocoris alpestris*). A common winter resident along the coasts; less common or very rare in the Hudson Valley.

Prairie Horned Lark (*Otocoris alpestris praticola*). This small race of the Horned Lark is of rather rare occurrence in this vicinity. It is apparently extending its range eastward and there is one record of its having probably bred on Long Island (Dutcher, Auk, V, 1888, p. 180), where it also occurs during the winter.

FAMILY CORVIDÆ. CROWS, JAYS, MAGPIES, ETC.

***Blue Jay** (*Cyanocitta cristata*). A common resident, more numerous during the fall migration than at other times of the year.

The Canada Jay (*Perisoreus canadensis*), a northern species, is included by Lawrence in his "Catalogue of Birds" on the basis of an individual killed in July near Manhattanville, New York City. This specimen is now in the American Museum (No. 42,253). Its plumage is much worn and its toe-nails are abnormally long, facts which, taken in connection with the place and date of the bird's capture, induce me to believe that it had escaped from confinement.

FIG. 15. BLUE JAY.

American Raven (*Corvus corax principalis*). Now of very rare occurrence in this vicinity. It is said to have been formerly common on the northern New Jersey coast (Lawrence), and is still uncommon along the southern coast of the State (Stone, Auk, XI, 1894, p. 137).

***American Crow** (*Corvus brachyrhynchos*). The Crow is here an abundant resident, but, as in the case of other species which are present the year round, it is probable that the individuals which summer with us pass the winter farther south, while our winter birds come to us from the north.

***Fish Crow** (*Corvus ossifragus*)). A common inhabitant of the Lower Hudson River Valley as far north as Sing Sing and occasionally reaches Highland Falls. In Connecticut it is of regular occurrence as far east as Stratford (Eames, Auk, VI, 1889, p. 338), while on Long Island its exact status appears to be unknown, though it is probably not uncommon. A few remain on the coast during the winter.

FAMILY STURNIDÆ. STARLINGS.

FIG. 16. STARLING, (SUMMER PLUMAGE).

***Starling** (*Sturnus vulgaris*). This Old World species has been introduced into this country on several occasions, but only the last importation appears to have been successful. The birds included in this lot were imported and released in Central Park, under the direction of Eugene Schieffelin of this city. They seem to have left the Park and to have established themselves in various places in the upper part of the city. A pair have bred for three successive seasons in the roof of this Museum. S. H. Chubb reports a pair nesting in a church at 122nd st. and Lenox avenue, and they also have nested at 100th st. and Riverside Drive. C. B. Isham tells me he has found their nest at Kingsbridge, New York City, and that he repeatedly observed a flock of fifty birds in the same locality during the late summer and fall of 1893 and 1894.

To the above statement, which stands as it appeared in the first (1894) edition of this List, may be added the further information, obtained from Mr. Schieffelin, that 80 Starlings were released on March 6, 1890, and 40 more on April 25, 1891. So far as I am aware the present (1906) boundary of the range of this species in America is marked by New Haven, Conn., on the east, Ossining, N. Y., on the north and Red Bank and Princeton, on the south. It is resident throughout the year, but gathers in flocks, sometimes containing several hundred birds, in the fall, when it wanders, about the country. Its economic status remains to be determined, but from the bird-

FIG. 17. STARLING, (WINTER PLUMAGE).

lover's point of view the Starling is a decided acquisition to the bird-life of our cities where its long-drawn, cheery whistle is in welcome contrast to the noisy chatter of House Sparrows.

FAMILY ICTERIDÆ. BLACKBIRDS, ORIOLES, ETC.

***Bobolink; Reedbird** (*Dolichonyx oryzivorus*). A locally distributed summer resident, arriving in early May and remaining until October. In August the males assume the Reedbird plumage and resort to our wild-rice marshes, where they are joined by large numbers from the north, which pause to feed on the wild-rice.

Twenty-five years ago the Bobolink was an abundant and generally distributed summer resident in this vicinity. Since that date it has rapidly decreased in numbers and is now entirely wanting in localities where it was formerly of regular occurrence.

FIG. 18. BOBOLINK.

***Cowbird** (*Molothrus ater*). A common summer resident arriving late in March and remaining until November. It has been recorded as occurring in winter (Foster, Abst. Proc. Linn. Soc., No. 5, 1893, p. 2).

***Red-winged Blackbird** (*Agelaius phœniceus*). A common summer resident, abundant during the migrations when it occurs in large flocks. It is one of the first birds to reach us in the spring, frequently arriving before March 1, and it remains until December.

***Meadowlark** (*Sturnella magna*). A common summer resident, occuring in reduced numbers during the winter, when it is largely confined to the extensive marshes near the coast.

***Orchard Oriole** (*Icterus spurius*). A common summer resident, arriving early in May and remaining until September. (See group, third floor).

***Baltimore Oriole** (*Icterus galbula*). A somewhat more common summer resident than the preceding species. It arrives early in May and remains until September. (See group, third floor).

***Rusty Blackbird** (*Euphagus carolinus*). A common migrant, passing northward in March, returning in September and sometimes remaining during the winter.

FIG. 19. RED-WINGED BLACKBIRD.

***Purple Grackle: Crow Blackbird** (*Quiscalus quiscula*). A common summer resident of local distribution, nesting in colonies. It is one of our earliest migrants, arriving from the south with the Red-winged Blackbird about March 1. During the breeding season it is not seen far from the vicinity of its nest, but about July 1, when the young are on the wing, the birds gather in small flocks and wander over the country, pausing wherever they find an abundance of food. These flocks gradually coalesce and, in October and November, form enormous gatherings numbering thousands of birds.

***Bronzed Grackle** (*Quiscalus quiscula æneus*). A spring and fall migrant, sometimes not uncommon.

FAMILY FRINGILLIDÆ. FINCHES, SPARROWS, ETC.

Evening Grosbeak (*Hesperiphona vespertina*). During the winter and early spring of 1890 there was a phenomenal incursion of Evening Grosbeaks into the northern United States. The most southern record of their occurrence in the Atlantic States was at Summit, N. J., where, on March 6, Mr. W. O. Raymond observed a flock of eight birds (Orn. and Oöl., XV, 1890, p. 46), No specimens were collected, but Mr. Raymond watched the birds for some time at a distance of about eight feet, and he has since examined skins of the species in this Museum, thus confirming his identification.

***Pine Grosbeak** (*Pinicola enucleator leucura*). This species occurs here in the winter and then only at irregular intervals. It last appeared in numbers during the winter of 1903-4 when it was first observed at Englewood, N. J., Oct. 25 (Chapman, Bird-Lore, V, 1903, p. 199).

FIG. 20. PINE GROSBEAK.

***House Sparrow; English Sparrow** (*Passer domesticus*). From the report of the Division of Economic Ornithology of the Department of Agriculture (Washington, 1889), we learn that English Sparrows were first introduced into New York City in 1860, when twelve birds were released in Madison Square. In 1864 they were introduced in Central Park, and in 1866 two hundred were set free in Union Park. From these, and one or two other small additional importations of a few pairs each, have descended the countless numbers of Sparrows which to-day inhabit our streets and parks. In this latitude the English Sparrow has been known to rear six broods in a season, and their marvelous rate of increase is graphically given in a table in the report already mentioned, which shows that in ten years the progeny of a single pair might amount to 275,716,983,698.

With the discordant notes of these ubiquitous little pests constantly in our ears we may read with mixed humor and regret the following quotation from Lawrence's Catalogue of New York Birds (Ann. Lyc. Nat. Hist., VIII, 1866, p. 287): "I first observed them in the spring of 1865. A friend, conversant with our local native birds, informed me that he had seen a species in the shrubbery around the church on the corner of 5th avenue and 29th street, with which he was not familiar; on going to ascertain what they were, to my surprise I found them to be House Sparrows; they were domiciled in the ivy which grew on the walls of the church, and were quite gentle and fearless, some alighting in the street and dusting themselves quite near to where I stood."

***The European Chaffinch** (*Fringilla cælebs*), several pairs of which were released in Central Park under the direction of Eugene Schieffelin in 1890, is occasionally observed in Central Park where three individuals appear to exist at present. Whether, however, they are the descendants of the introduced birds or escaped cage-birds is unknown.

***The Greenfinch** (*Chloris chloris*) a European species was observed in Central Park, May 17, 1903, by C. G. Abbott.

***Purple Finch** (*Carpodacus purpureus*). In the vicinity of New York City the Purple Finch is a rather rare summer resident, a very common migrant and irregular winter resident. It is apparently increasing in numbers during the summer on Long Island (Dutcher, MS).

***American Crossbill** (*Loxia curvirostra minor*). A regular winter visitant. This erratic species has on several occasions been found breeding south of its regular breeding range. Such an instance occurred at Riverdale, N. Y., where it was found nesting on April 22, 1874 (Bicknell, Bull. N. O. C., IV, 1880, p. 7).

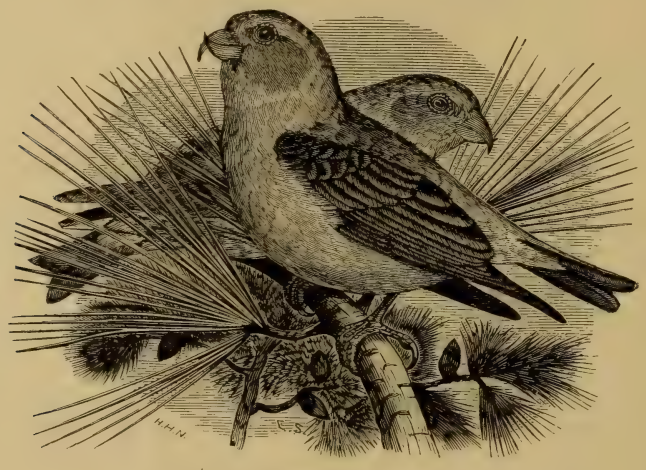

FIG. 21. AMERICAN CROSSBILL.

***White-winged Crossbill** (*Loxia leucoptera*). Of more rare and irregular occurrence in winter than the preceding species. This and the preceding species last occurred in numbers during the winter of 1899-1900 (Chapman Bird-Lore, II, 1900, pp. 25, 59).

Redpoll (*Acanthis linaria*). This species is here an irregular winter visitant, sometimes occurring in considerable numbers.

Greater Redpoll (*Acanthis linaria rostrata*). Two specimens taken at Sing Sing, N. Y., are the only individuals of this species which have been recorded from this vicinity (Fisher, Bull. N. O. C., VIII, 1883, p. 121).

The European Linnet (*Acanthis cannabina*) is recorded from Scarboro, N. Y. (G. H. Thayer, Auk, XVII, 1900, p. 389); but the large number of cage-birds of this species annually imported into this country makes it probable that the bird secured was an assisted immigrant.

FIG. 22. REDPOLL.

***American Goldfinch** (*Astragalinus tristis*). The Goldfinch, Yellowbird, or Thistlebird, is a common resident here.

FIG. 23. AMERICAN GOLDFINCH.

***European Goldfinch** (*Carduelis carduelis*). A European species which was introduced into this country at Hoboken, N. J., in 1878. The following year it appeared in Central Park and has since spread over the upper parts of the city where in favorable localities it is not uncommon. It is with us throughout the year. (Adney, Auk, III, 1886, p. 409).

***Pine Siskin; Pine Finch** (*Spinus pinus*). A more or less common fall and winter visitant. On two occasions it has been found nesting in the Lower Hudson Valley, at Sing Sing, May 25, 1883 (Fisher, Bull. N. O. C., VIII, 1883), and at Cornwall-on-Hudson, May 12, 1887 (Allen, Auk, IV, 1887, p. 284). (See group, third floor).

***Snowflake; Snow Bunting** (*Passerina nivalis*). On Long Island this bird is an abundant winter resident on the sand-flats near the ocean (Dutcher, MS). In the Lower Hudson Valley it is much less common.

Lapland Longspur (*Calcarius lapponicus*). A rare winter resident; sometimes found with flocks of the preceding, but more frequently associated with Horned Larks.

Chestnut-collared Longspur (*Calcarius ornatus*). "Interior of North America, from the Saskatchewan Plains south to Texas." A specimen of this western species was taken at Long Island City, February 16, 1889 (Hendrickson, Auk, VI, 1889, p. 190).

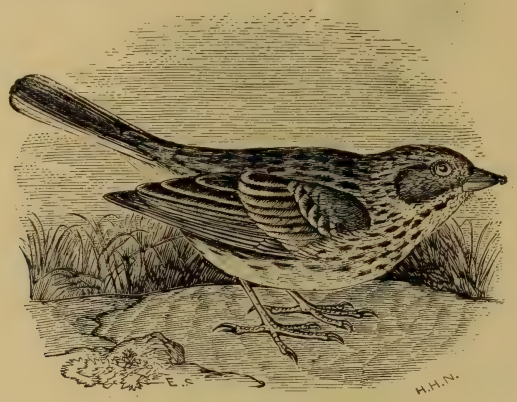

FIG. 24. VESPER SPARROW.

***Vesper Sparrow; Grass Finch: Bay-winged Bunting** (*Poœcetes gramineus*). A common summer resident, arriving about April 1, and remaining until the latter part of November.

Ipswich Sparrow (*Passerculus princeps*). A common winter resident, confined strictly to the immediate vicinity of the coasts, where it is found from the middle of October to the first of April (Dutcher, Auk, III, 1886, p. 441).

***Savanna Sparrow** (*Passerculus sandwichensis savanna*). This species is here a rare summer resident and abundant migrant, arriving about April 1 and departing in November and December. It breeds at Morristown, N. J. (Thurber) and is said to remain throughout the winter in the salt-marshes at Bridgeport, Conn. (Averill) Braislin, (Auk, XVI, 1899, p. 192) records it from Garden City, L. I., July 17, 1897, and Flatbush, L. I., Jan. 30, 1895.

Grasshopper Sparrow; **Yellow-winged Sparrow** (*Coturniculus savannarum passerinus*). Locally a common summer resident, arriving about May 1 and remaining until October.

Henslow Sparrow (*Ammodramus henslowi*). In this vicinity the Henslow sparrow has been found in but few localities where, however, it is apparently not uncommon. It is recorded as breeding at Morristown, N. J. (Thurber), and Boonton, Morris County, N. J. (Judd, Auk, XIV, 1897, p. 326). Summer resident in small numbers near Plainfield, N. J. (Miller, MS).

Sharp-tailed Sparrow (*Ammodramus caudacutus*). An abundant summer resident; with the exception of a colony on the Hudson at Piermont, confined entirely to the salt marshes of our coasts. (See group, third floor).

Nelson Sharp-tailed Sparrow (*Ammodramus nelsoni*). This species is known here only as a rather rare fall migrant in the Hudson River Valley, occurring from the latter part of September to the latter part of October.

Acadian Sharp-tailed Sparrow (*Ammodramus nelsoni subvirgatus*). Occurs with the preceding. (On the distribution of the Sharp-tailed Sparrows see Dwight, Auk, XIII, 1896, p. 275).

FIG. 25. SEASIDE SPARROW.

Seaside Sparrow (*Ammodramus maritimus*). This is an even more abundant summer resident than the Sharp-tailed Sparrow and, like it, is confined exclusively to our coasts, with the exception of a colony in the Piermont marshes. (See group, third floor).

Lark Sparrow (*Chondestes grammacus*). Interior of North America, eastward to Illinois, breeding from Texas to Manitoba; accidental on the Atlantic coast. There are two records for this vicinity, Sayville, L. I., August 20, 1879 (Earle, Bull. N. O. C., VI, 1881, p. 58) and Schraalenburg, N. J., November 26, 1885 (Chapman, Auk, III, 1886, p. 136).

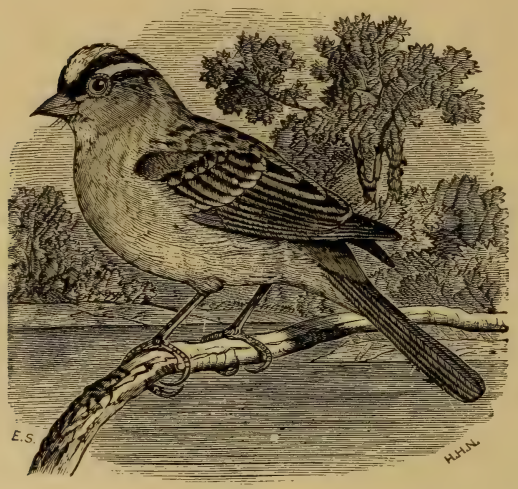

FIG. 26. WHITE-CROWNED SPARROW.

***White-crowned Sparrow** (*Zonotrichia leucophrys*). A rather rare migrant passing norhtward in May and returning in October. Braislin (Auk, XV, 1898, p. 59) records a specimen taken at Parkville, L. I., April 10, 1897.

***White-throated Sparrow** (*Zonotrichia albicollis*). An abundant migrant and locally common winter resident. It arrives from the north the latter part of September and remains with us until the middle of May.

***Tree Sparrow** (*Spizella monticola*). An abundant winter resident, arriving from the north about November 1 and remaining until April.

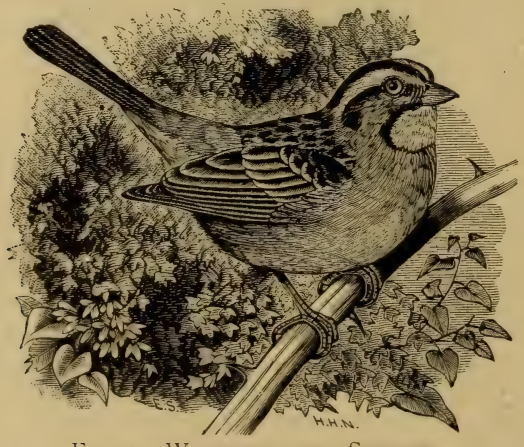

FIG. 27. WHITE-THROATED SPARROW.

***Chipping Sparrow; Chippy** (*Spizella socialis*). An abundant summer resident, arriving from the south about April 1 and remaining until November.

***Field Sparrow** (*Spizella pusilla*). An abundant summer resident, appearing in the spring about April 1 and not departing southward until November or even December. Of rare but regular occurrence in winter at Plainfield, N. J. (Miller, MS). (See group, third floor).

***Junco; Snowbird** (*Junco hyemalis*). The Junco is one of our most abundant winter birds. It comes to us from the north late in September and remains until May.

FIG. 28. JUNCO.

***Song Sparrow** (*Melospiza cinerea melodia*). An abundant summer and common winter resident. (See group, third floor).

Lincoln Sparrow (*Melospiza lincolni*). In this vicinity the Lincoln Sparrow is a rare but regular migrant, passing northward in May and southward in September and October.

***Swamp Sparrow** (*Melospiza georgiana*). An abundant summer resident, especially in the great marshes of the Hackensack, and a rare winter resident. (See group, third floor).

***Fox Sparrow** (*Passerella iliaca*). A common spring and fall migrant, passing northward in March and April and southward in October and November. There are several winter records for Princeton, N. J. (Scott, Bull, N. O. C., IV, 1879, p. 82).

***Towhee; Chewink** (*Pipilo erythrophthalmus*). An abundant summer resident, arriving about April 20, remaining until late October, and rarely into the winter. (See group, second floor).

***Cardinal** (*Cardinalis cardinalis*). The vicinity of New York City is about the northern limit of the Cardinal's range on the Atlantic coast. It is here a not uncommon resident of local distribution. In the Hudson Valley it is rarely found north of Hastings and Nyack; it is very rare eastward along the sound, and also on Long Island, but is common in Central Park, New York City, where I have seen nine individuals at one time. (See group, second floor).

***Rose-breasted Grosbeak** (*Zamelodia ludoviciana*). A common summer resident in the Hudson River Valley, arriving about May 1 and remaining until October. On Long Island it is a rare summer resident (Dutcher, MS). (See group, second floor).

***Blue Grosbeak** (*Guiraca cærulea*). There are several records of this southern bird's occurrence in this vicinity. It has been taken at Canarsie, L. I., May, 1843 (Dutcher, Auk, V, 1893, p. 276); Morristown, N. J. (Thurber, True Democratic Banner, newspaper, Nov. 17, 1889); Snake Hill, N. J. (Bicknell, Bull. N. O. C., III, 1878, p. 132), and Manhattan Island (DeKay, Birds, N. Y., p. 146).

***Indigo Bunting** (*Cyanospiza cyanea*). A common summer resident in this vicinity, arriving about May 1 and remaining until October 1.

Painted Bunting (*Cyanospiza ciris*). Breeds from the Gulf States northward to Kansas, southern Illinois and North Carolina. The capture of several specimens of this bird in this vicinity has been recorded (Bicknell, Bull. N. O. C., III, 1878, p. 132). It is possible that they were escaped cage-birds.

Dickcissel; Black-throated Bunting (*Spiza americana*). Eastern United States, mostly in the Mississippi Valley, breeding from Texas to Minnesota, and wintering in Central and South America. Breeds east of the Alleghanies now only rarely and locally. About forty years ago this bird was evidently a regular and not uncommon summer resident in this vicinity. (See Giraud, Chapman *apud* Galbraith, Auk, VIII, 1891, p. 395), but it occurs now only rarely and irregularly. Recent records are: Miller's Place, L. I., September 29 and October 10 (Dutcher, Auk, VI, 1889, p. 13) and Blithewood, L. I., August 25 (Johnson, Auk, VIII, 1891, p. 116). In July, 1904, W. De Witt Miller found a pair of this species breeding at Plainfield, N. J. (Auk, XXI, 1904, p. 487). J. Dwight, Jr., records the occurrence of a male Dickcissel at Kingston, N. Y., June 5, 1897 (Auk, XIV, 1897, p. 95).

Family TANAGRIDÆ. Tanagers.

Western Tanager (*Piranga ludoviciana*). Western North American north to British Columbia. The only record of the occurrence of this western species in this vicinity is that of a young male taken at Fort Montgomery, N. Y., December 21, 1881 (Mearns, Auk, VII, 1890, p. 55).

***Scarlet Tanager** (*Piranga erythromelas*). A common summer resident, arriving early in May and remaining until about October 1. (See group, third floor).

Summer Tanager (*Piranga rubra*). Eastern United States, breeding from Florida to southern New Jersey, wandering casually to Nova Scotia, and wintering in Central and South America. This species is of rare and irregular occurrence in this vicinity. (Hendrickson, Auk, 1, 1885, p. 290; Dutcher, Auk, III, 1886, p. 412; XIX, 1902, p. 291; V, 1888, p. 181; Mearns, Auk, VII, 1890, p. 55; Braislin, Auk, XIX, 1902, p. 147).

FAMILY HIRUNDINIDÆ. SWALLOWS.

***Purple Martin** (*Progne subis*). This bird breeds in colonies and is of local distribution during the breeding season. It was formerly not uncommon in the vicinity of New York City, but the English Sparrows have taken possession of its nesting-houses, and at present it is found in but few places.

***Cliff Swallow; Eave Swallow** (*Petrochelidon lunifrons*). Like most of the Swallows it nests in colonies, and in this region generally places its mud nests beneath the projecting eaves of a barn. It appears to be less common during the summer than it was twenty or more years ago, but is a common migrant particularly in the fall. According to Mearns, it arrives as early as April 16. (See group, second floor).

***Barn Swallow** (*Hirundo erythrogaster*). A common summer resident and abundant fall migrant. It arrives about April 20 and remains until October 1.

***Tree Swallow** (*Iridoprocne bicolor*). Arrives from the south early in April. There are a few recorded instances of its breeding near New York City, but, generally speaking, it passes northward to more distant nesting grounds. July 1 the birds begin to return from the north, making their home in the marshes of the Hackensack, where, by July 20, they may be found in countless numbers. In the morning they leave their roosts in the "cat-tails" and fly out over the adjoining country to feed. At night they return. Their numbers increase until about September 1, then decrease, and by October 20 only a few stragglers remain.

***Bank Swallow** (*Riparia riparia*). A locally common summer resident, breeding in colonies where the conditions are favorable. It arrives about May 1 and remains until October. (See group, second floor).

Rough-winged Swallow (*Stelgidopteryx serripennis*). This Swallow is locally common in the Lower Hudson River Valley, at Riverdale (Bicknell), Hastings-on-the-Hudson (Rowley), Sing Sing (Fisher); at Highland Falls, which seems to be near the northern limit of its range in the Hudson Valley, it is a rare summer resident (Mearns). I have seen it near Ramapo, N. Y., and with J. Dwight, Jr., found a small colony breeding at Port Jervis, N. Y. It breeds near New Haven, Connecticut, in small numbers, and is rare as far north as Hartford (Sage). On Long Island it is of rare and irregular occurrence (Dutcher).

FAMILY AMPELIDÆ. WAXWINGS, ETC.

Bohemian Waxwing (*Ampelis garrulus*). This species occurs here only as an exceedingly rare and irregular winter visitant. There are no recent records.

***Cedar Waxwing; Cedarbird** (*Ampelis cedrorum*). A common summer resident; occurring irregularly in the winter.

FAMILY LANIIDÆ. SHRIKES.

***Northern Shrike; Butcherbird** (*Lanius borealis*). A more or less regular but rather uncommon winter resident.

FIG. 29. NORTHERN SHRIKE.

Migrant Shrike (*Lanius ludovicianus migrans*). The Migrant Shrike is found here is a rare but regular migrant during April, the latter part of August and in September, and, rarely, until December. It has been known to breed but once, at Sing Sing, N. Y., where a fledgeling was taken June 16, 1877 (Fisher, Bull. N. O. C., IV, 1879, p. 61).

FAMILY VIREONIDÆ. VIREOS.

***Red-eyed Vireo** (*Vireosylva olivacea*). This is one of our abundant summer residents. It arrives from the south about May 8 and remains until October. (See group, third floor).

Philadelphia Vireo (*Vireosylva philadelphica*). A very rare migrant.

***Warbling Vireo** (*Vireosylva gilva*). A common summer resident of local distribution, arriving early in May. (See group, third floor).

***Yellow-throated Vireo** (*Lanivireo flavifrons*). A common summer resident, arriving about May 7 and remaining until the latter part of September.

***Blue-headed Vireo** (*Lanivireo solitarius*). A not uncommon migrant, passing northward during the latter part of April and first part of May, and returning late in September.

***White-eyed Vireo** (*Vireo noveboracensis*). A common summer resident about New York City. It reaches us from the south about May 7, and remains until early October. (See group, third floor).

FAMILY MNIOTILTIDÆ. WOOD-WARBLERS.

***Black and White Warbler** (*Mniotilta varia*). A rather common summer resident and common migrant. It appears the latter part of April and is with us until the first part of October. (See group, third floor).

Prothonotary Warbler (*Protonotaria citrea*). Eastern North America, breeding from the Gulf States to southern Illinois and Virginia, and wintering in the tropics. Its occurrence near New York City is accidental; there are but two records, viz., a male shot at Jamaica, L. I. (Dutcher, Auk, X, 1893, p. 276), and a male seen by E. P. Bicknell near the northern limit of New York City, June 2, 1895 (Auk, XII, 1895, 306). Dutcher has recorded a specimen which struck the Montauk Point Lighthouse, August 27, 1886 (Auk, V, 1888, p. 182).

***Worm-eating Warbler** (*Helmitheros vermivorus*). This bird is one of our rarer summer residents, though it is not uncommon some years in the early fall migration. In the Hudson River Valley it is regularly found as far north as Highland Falls (Mearns) and occurs at Fishkill (Stearns). In Connecticut it breeds at Saybrook and New Haven, but is not common, and at Portland it has been taken only twice (Sage). On Long Island it is considered exceedingly rare (Dutcher).

***Blue-winged Warbler** (*Helminthophila pinus*). This species arrives early in May and remains until September 1. It is a common summer resident of the Lower Hudson Valley, at least as far north as Highland Falls (Mearns). In Connecticut it is common at Saybrook and New Haven, but is rare as far north as Portland, where but one or two pairs breed each season (Sage). On Long Island it is known to breed only along the north shore, where it is probably not uncommon in favorable localities. Mrs. E. G. Britton records the occurrence of an individual of this species in Bronx Park in January, 1900 (Bird-Lore, II, 1900, p. 26; see also Noble, Bird-Lore, II, 1900, p. 59). (See group, third floor).

Brewster's Warbler (*Helminthophila leucobronchialis*) with us is a rare but regular summer resident in northern New Jersey, the Lower Hudson Valley and southern Connecticut, but has been taken only once on Long Island (Howell). Specimens have been recorded from Morristown (Thurber), Maplewood (Riker), and Englewood, N. J., where it has been found nesting (Chapman, Auk, IV, 1887, p. 348; IX, 1892, p. 302). Farther north in the Hudson Valley it has been found at Nyack (Bicknell), and at Sing Sing five specimens have been secured (Fisher, Bull. N. O. C., IV, 1879, p. 234; VI, 1881, p. 245; Auk, II, 1885, p. 378) In the Lower Connecticut Valley this bird seems to be more frequent than in any other part of its range. It has been found at Saybrook, Seymour, New Haven, Portland and other localities, the principal records being as follows: Eames, Auk, V, 1888, p. 427; VI, 1889, p. 305; Bishop, Auk, VI, 1889, p. 192; Sage, Auk, X, 1893, p. 208. Probably not more than one-third of all the specimens recorded are typical *leucobronchialis*, the remaining two-thirds presenting every stage of intergradation between this bird and typical *H. pinus*.

Lawrence's Warbler (*Helminthophila lawrencei*) is a much rarer bird than the preceding. There are records for only six specimens from the immediate vicinity of New York City, viz. Chatham, N. J. (Herrick), Hoboken, N. J. (Lawrence), Rye, N. Y. (Vorhees, Auk, V, 1888, p. 427), Greenwich, Conn. (Vorhees, Auk, XI, 1894, p. 259), Cold Spring Harbor, L. I. (Braislin, Auk, XX, 1903, p. 53), and New York Zoological Park, where a male was found breeding with a female *pinus* (Bildersee, Bird Lore, VI, 1904, p. 131; Beebe, Auk, XXI, 1904, p. 387).

The status of both Brewster's and Lawrence's Warblers is still unsettled. They are generally considered to be hybrids between *H. pinus* and *H. chrysoptera*, and it has also been suggested that dichromatism may play a part in producing their coloration. Their relationship will be found discussed under the following references: Brewster, Bull. N. O. C., VI, 1881, p. 218; Ridgway, Auk, II, 1885, p. 359; Manual N. A. Birds, 1887, p. 486; Birds of North and Middle America, II, 1902, pp. 452, 453; Thayer, Auk, XIX, 1902, p. 401; Bishop, Auk, XXII, 1905, p. 21).

***Golden-winged Warbler** (*Helminthophila chrysoptera*). In the immediate vicinity of New York City, this bird occurs as a rather rare spring migrant, but in the early southward migration, in August, it is sometimes not uncommon. It has been found nesting at Nyack, N. Y. (Brownell) and probably breeds regularly from that point northward.

***Nashville Warbler** (*Helminthophila rubricapilla*). This species is here a rather common migrant and a rare summer resident as far south as Highland Falls. It arrives about May 10 and returns on its southward journey during late August, the last migrants being seen about September 25. A breeding female was taken by Chapman at Englewood, N. J., June 16, 1887, (Auk, VI, 1889, p. 304).

Orange-crowned Warbler (*Helminthophila celata*). This Warbler occurs here as an exceedingly rare migrant. There are records of only six specimens, all but one of which occurred in the fall. (Howell, Auk, X, 1893, p. 91).

***Tennessee Warbler** (*Helminthophila peregrina*). With us this bird is a rather rare spring migrant but is sometimes not uncommon in the fall. It passes northward early in May and returns on its southward journey in September.

***Northern Parula Warbler** (*Compsothlypis americana usneæ*). The Parula Warbler is here a more or less abundant migrant and local summer resident. It arrives from the south about May 7 and the last individuals are observed in early October.

***Cape May Warbler** (*Dendroica tigrina*). This is one of our rarest spring migrants, passing northward about May 15. In the fall migration immature birds are sometimes not uncommon.

***Yellow Warbler** (*Dendroica æstiva*). A common summer resident. It arrives from the south about May 5 and remains until September. (See group, third floor).

***Black-throated Blue Warbler** (*Dendroica cærulescens*). A common migrant, passing northward early in May and returning in September.

FIG. 30. MYRTLE WARBLER.

***Myrtle Warbler; Yellow-rumped Warbler;** (*Dendroica coronata*). An abundant migrant in our vicinity and in favorable localities where bayberries are abundant, it passes the whole winter. Migrants begin to arrive in early April, and the southward migration takes place during the latter part of September and October.

***Magnolia Warbler** (*Dendroica maculosa*). In this vicinity it is a common migrant, passing northward early in May and returning late in August and in September.

Cerulean Warbler (*Dendroica cerulea*). Breeds in the Mississippi Valley as far north as Minnesota, and eastward as far as Cayuga Co., N. Y., and winters in the tropics. Its occurrence here is accidental, and there are but three records of its capture, one of a male taken in Kings County, L. I., (Dutcher, Auk, X, 1893, p. 277), of a male taken at Highland Falls, May 17, 1875 (Mearns, Birds Hudson Highlands, p. 154), and one of a specimen taken at Boonton, Morris Co., N. J., in September, 1887 (Judd, Auk, XIV, 1897, p. 326).

***Chestnut-sided Warbler** (*Dendroica pensylvanica*). With us it is a common migrant, and, in recent years, has become a locally common summer resident. It arrives early in May, and the return migration occurs between August 10 and October 1.

***Bay-breasted Warbler** (*Dendroica castanea*). As a rule the Bay-breasted is one of our rarest transient Warblers but during some seasons it is found in numbers. It passes northward about the middle of May and returns in September.

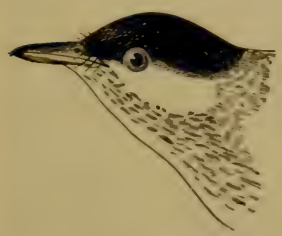

FIG. 31. BLACKPOLL WARBLER.

***Blackpoll Warbler** (*Dendroica striata.*) The Blackpoll is one of our most abundant migrants and is the last of the transient Warblers to pass northward in the spring. It arrives from the south about May 7 and returns on its southern journey in September.

***Blackburnian Warbler** (*Dendroica. blackburniæ*). A rather uncommon spring migrant, passing northward during the first of May, but is not uncommon some year during its return migration in September.

Yellow-throated Warbler (*Dendroica domina*). Southern United States, breeding as far north as Virginia and wintering from Florida southward. There is but one record of the occurrence of this southern species near New

York City. It is based on the capture of a male in Kings County, L. I. (Dutcher, Auk, X, 1893, p. 277).

***Black-throated Green Warbler** (*Dendroica virens*). In the immediate vicinity of New York City this bird is found chiefly as a migrant, arriving from the south late in April and returning about the middle of August. It is known to breed at Highland Falls, N. Y. (Mearns), Bridgeport, Conn. (Averill), Millers Place, L. I. (Dutcher, MS), and at Demarest, N. J., where on June 5, 1904. B. S. Bowdish found a nest built in a skunk cabbage about fourteen inches from the ground (Auk, XXIII, 1906, p. 17).

***Pine Warbler** (*Dendroica vigorsi*). This Warbler is of local distribution in this vicinity. In northern New Jersey, the Lower Hudson Valley and southern Connecticut it occurs only as a rare migrant, but on certain parts of Long Island, where the scrub pines afford it congenial surroundings, it is not uncommon and breeds.

Palm Warbler (*Dendroica palmarum*). This species is of rather rare but regular occurrence here. One specimen was taken at Sing Sing, N. Y., April 29, 1882 (Fisher, Bull. N. O. C., VII, 1882, p. 249), two at Riverdale, N. Y., in the spring of 1877 (Bicknell, Bull. N. O. C., V. 1880, p. 182), and one struck the Fire Island Lighthouse, September 23, 1887 (Dutcher, Auk, V, 1888, p. 182). Braislin (Auk, XIX, 1902, p. 149) records it as "common" near Brooklyn between September 25 and October 7, 1895, and Miller (Bird-Lore, V, 1903, p. 199) states that it was rather common near Plainfield, N. J., between September 22 and October 4, 1903.

***Yellow Palm Warbler; Yellow Redpoll** (*Dendroica palmarum hypochrysea*). A common migrant arriving from the south about April 10, and returning late in September and in October.

***Prairie Warbler** (*Dendroica discolor*). The distribution of the Prairie Warbler in this vicinity is much like that of the Pine Warbler. It is rare in northern New Jersey and the Lower Hudson Valley, where however, it has been found breeding once (Highland Falls, Mearns), but is not uncommon on some parts of Long Island. At Bridgeport, Conn., it is a common migrant and may breed (Averill). (See group, third floor).

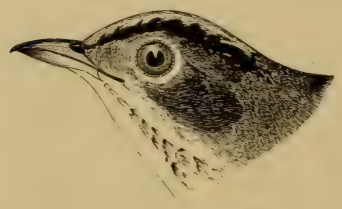

Fig. 32. Ovenbird.

***Ovenbird** (*Seiurus aurocapillus*). The Ovenbird is one of our abundant summer residents, arriving about May 1 and remaining until the middle of October. (See group, third floor).

Northern Water-thrush (*Seiurus noveboracensis*). A common migrant, passing northward during May and returning about September 1. Cherrie (Auk, XIX, 1902, p. 210) records the probable breeding of this species at Cold Spring Harbor, L. I.

LOUISIANA WATER THRUSH
Group, Hall No. 308

Grinnell's Water-thrush (*Seiurus noveboracensis notabilis*). Western North America; eastward during the migrations to Virginia and South Atlantic States. This western species has been recorded only from Raritan, N. J., May 30, 1889 (Southwick, Auk, IX, 1892, p. 303), and Princeton, N. J. Sept. 10, 1879 (Babson).

Louisiana Water-thrush (*Seiurus motacilla*). It is a common summer resident in the lower Hudson Valley, where it has been found as far north as Lake George (Fisher), and is not uncommon in the lower Connecticut Valley. There are two records for Massachusetts and two for Rhode Island. On Long Island it is very rare (Dutcher). (See group, third floor).

FIG. 33. KENTUCKY WARBLER.

***Kentucky Warbler** (*Opornis formosa*). This is a common summer resident on the banks of the Lower Hudson River and has been recorded from Fort Lee and Riverdale (Bicknell), Englewood (Chapman), and Sing Sing (Fisher), beyond which point it is as yet unknown. In Connecticut there are but three records, viz: at Suffield where a male was taken August 16, 1876 (Merriam), at Greenwich, where a pair and a fledgeling were seen and the male taken July 10, 1892 (Vorhees, Auk, X, 1893, p. 86) and at West Stratford, where a male was shot May, 30, 1888 (Lucas, Orn. and Ool., XIV, 1889, p. 62). On Long Island it is very rare, there being but one recent record if its occurrence (Dutcher). It is wholly absent in the vicinity of Plainfield, N. J., (Miller) and at Princeton (Babson).

Connecticut Warbler (*Oporornis agilis*). This species is an exceedingly rare spring migrant east of the Alleghanies, and I know of no record of its occurrence here at that season; in the fall, however, it is not uncommon, and sometimes is abundant, arriving as early as September 3 and remaining until the latter part of the month.

***Mourning Warbler** (*Oporornis philadelphia*). This species is one of our rare Warblers; it passes northward during the latter half of May.

***Northern Yellowthroat** (*Geothlypis trichas brachidactyla*). One of our most abundant summer residents. It arrives about May 5 and remains until October. (See group, third floor.)

Yellow-breasted Chat (*Icteria virens*). A common summer resident, arriving about May 5 and remaining until September.

***Hooded Warbler** (*Wilsonia mitrata*). The Hooded Warbler is here near the northern limit of its range. At Englewood, N. J., it is an abundant summer resident, arriving about May 5 and remaining until the middle of September. At Riverdale, N. J., it is locally common (Bicknell), at Sing Sing it is not common (Fisher), but at Highland Falls it is "very common" (Mearns). It has been taken at Fishkill, the most northern point in the

Hudson River Valley from which it has been recorded. In Connecticut it is common at Saybrook and New Haven, but is rare north of these points (Sage). In Massachusetts it has been found only twice. On Long Island it is rare. At Plainfield and Princeton, N. J., it is a rare migrant.

***Wilson's Warbler** (*Wilsonia pusilla*). This bird is here a rather uncommon spring migrant, passing northward from the 12th to the 30th of May, but is not uncommon at times during its return journey, which takes place between August 15 and September 15.

***Canadian Warbler** (*Wilsonia canadensis*). A common migrant, passing north from May 10 to June 10 and returning between August 5 and September 10.

***American Redstart** (*Steophaga ruticilla*). A common summer resident of our woodland; it arrives about May 5 and remains until early October. (See group, third floor.)

Family MOTACILLIDÆ. Wagtails.

***American Pipit; Titlark** (*Anthus pensilvanicus*). The Titlark is a generally common, and, along our coasts, an abundant migrant. It travels northward from the latter part of March to early May and returns on its southern journey during October and November.

Family MIMIDÆ. Mockingbirds, Thrashers, etc.

***Mockingbird** (*Mimus polyglottos*). Breeds from the Bahamas and Mexico to southern Illinois and northern New Jersey, rarely to Massachusetts, and winters from North Carolina southward. The Mockingbird is of rare occurrence in this vicinity and doubtless many of the specimens reported are escaped cage-birds. It has, however, been found breeding at several localities, and at Tenafiy, N. J., a pair returned to the same locality for several years (Auk, VI, 1889, p. 305). On several occasions Mockingbirds have been found here during the winter and have shown their ability to withstand our coldest weather as long as they can obtain an abundance of food.

***Catbird** (*Galeoscoptes carolinensis*). An abundant summer resident, arriving about May 3 and remaining until October 20. (See group, third floor.)

***Brown Thrasher** (*Toxostoma rufum*). A common summer resident, appearing about April 20 and remaining until the middle of October and occasionally later. (See group, second floor.)

Family TROGLODYTIDÆ. Wrens.

***Carolina Wren** (*Thryothorus ludovicianus*). Eastern United States, breeding from the Gulf States to southern Iowa, northern Illinois, and southern Connecticut; resident, except at the northern limit of its range. Generally speaking the Carolina Wren is a rather rare bird in this vicinity but on the

FIG. 34. CAROLINA WREN.

eastern slope of the Palisades, as far north as Piermont, N. Y., it is common during the summer (Chapman, Auk, X, 1893, p. 87). It has been found on Long Island in the winter (Dutcher, MS). Since the above was written, in 1894, this species appears to have increased in numbers, locally.

***House Wren** (*Troglodytes aedon*). This common and familiar species comes to us about May 1 and remains until October.

***Winter Wren** (*Olbiorchilus hiemalis*). Just before the House Wren leaves us, or about October 1, the Winter Wren comes from the north and is not uncommon until the House Wren returns in May.

Short-billed Marsh Wren (*Cistothorus stellaris*). This species is here a common summer resident of very local distribution.

FIG. 35. WINTER WREN.

Long-billed Marsh Wren (*Telmatodytes palustris*). This abundant inhabitant of our reedy marshes arrives in May and remains until October or November.

FAMILY CERTHIIDÆ. CREEPERS.

***Brown Creeper** (*Certhia familiaris americana*). The Creeper is here a rather common winter resident, arriving from the north about October 1 and remaining until April.

FAMILY SITTIDÆ. NUTHATCHES.

***White-breasted Nuthatch** (*Sitta carolinensis*). A common permanent resident.

***Red-breasted Nuthatch** (*Sitta canadensis*). This bird is sometimes common from the later part of August to October and occasionally remains during the winter.

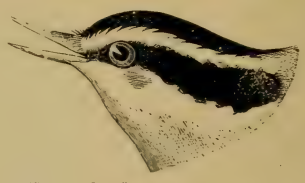

FIG. 36. RED-BREASTED NUTHATCH.

FAMILY PARIDÆ. TITMICE.

Tufted Titmouse (*Bæolophus bicolor*). This bird is resident and breeds as far north as Orange, N. J. (Riker), and Staten Island, N. Y. (Hollick). Beyond these points it occurs regularly but rarely. It is observed yearly in April at Englewood, N. J. (Chapman). There are few records for Connecticut, and although Giraud leads us to believe it was not uncommon and bred on Long Island when he wrote, it is now very rare there. (Braislin, Auk, XIX, p. 148.)

FIG. 37. CHICKADEE.

***Chickadee** (*Penthestes atricapillus*). The Chickadee is here a common permanent resident, but is more numerous during its migration in October than at other times.

Carolina Chickadee (*Penthestes carolinensis*). "Southeastern United States, north to New Jersey and Illinois." This species reaches the southern limit of our district at Princeton, N. J., where it is a not uncommon resident, while *P. atricapillus* is found there only in the winter (Babson).

FAMILY SYLVIIDÆ. KINGLETS AND GNATCATCHERS.

***Golden-crowned Kinglet** (*Regulus satrapa*). A not common winter resident in favorable localities; it arrives from the north about October 1 and remains until May.

FIG. 38. GOLDEN-CROWNED KINGLET.

***Ruby-crowned Kinglet** (*Regulus calendula*). A common spring, and an abundant fall migrant, arriving from the south about the middle of April and returning late in September.

***Blue-gray Gnatcatcher** (*Polioptila cærulea*). Eastern United States, breeding from the Gulf States to northern Illinois, southern Ontario and northern New Jersey, and wandering rarely to Minnesota and Maine, winters from Florida southward. There are numerous records of capture of this southern species in the vicinity of New York City, but it is not known to occur regularly nearer than Princeton, N. J., where it arrives from "April 25 to May 1" (Scott, The Country, I. 1878, p. 354).

Townsend's Solitaire (*Myadestes townsendi*). A male of this species was taken at King's Park, L. I., November 25, 1905, by J. A. Weber (Dwight, Auk, XXIII, 1906, p. 105).

***Wood Thrush** (*Hylocichla mustelina*). The Wood Thrush is an abundant summer resident, arriving about May 1 and remaining until early October. It

may rightly claim to rank as the most gifted of our summer songsters. (See group, second floor.)

Wilson's Thrush (*Hylocichla fuscescens*). Wilson's Thrush, or the Veery, as it is better called, is a common summer resident, arriving about May 1 and remaining until September. (See group, third floor.)

Gray-cheeked Thrush (*Hylocichla aliciæ*). A common migrant, passing northward in May and southward in September and October.

Bicknell's Thrush (*Hylocichla bicknelli*). So far as records go, this is a rather rare migrant, occurring in May and September and October, but careful search will doubtless show it to be more common than is generally supposed.

Olive-backed Thrush (*Hylocichla ustulata swainsoni*). The Olive-backed Thrush is a common migrant in this vicinity. It passes northward in May and southward in September and October.

Hermit Thrush (*Hylocichla guttata pallasi.*) An abundant migrant and occasionally is found in small numbers during the winter. In the spring it passes northward between April 10 and May 1; its fall migration takes place between October 1 and November 1. There is a record of its probable breeding at Lake Ronkonkoma, L. I. (Dutcher, Auk, III, 1886, p. 443).

American Robin (*Merula migratoria*). The Robin is our most abundant summer resident, and in favorable localities a few may be found in the winter Migrants begin to arrive toward the last of February, and the species is abundant until December. (See group, third floor.)

Varied Thrush (*Ixoreus nævius subsp. ?*). The local status of this Pacific coast bird appears to be well stated in Coues' "Birds of the Colorado Valley," where George N. Lawrence is quoted as follows:

"Besides Cabot's New Jersey example, two others have been procured near New York City—one at Islip, Long Island, shot in the fall, in company with Robins, and now in the possession of the person who secured it, the other at Hoboken, New Jersey. Both were received in the flesh by Mr. J. Akhurst, to be mounted; the Hoboken one was subsequently destroyed by fire in the taxidermist's workshop. All the specimen's in my own cabinet came from the Pacific side."

The Cabot specimen mentioned above by Lawrence is possibly the one referred to by Turnbull (Birds of East. Penn. and N. J.), but without data.

Wheatear (*Saxicola œnanthe leucorhoa*). This northern species is of accidental occurrence in this vicinity; it has been twice recorded from Long Island (Lawrence, Ann. Lyc. Nat. Hist., VIII, 1886, p. 282; Dutcher, Auk, X, 1893, p. 277.)

Bluebird (*Sialia sialis*). The Bluebird is here a common summer resident, an abundant migrant, and not infrequent winter resident. Migrants begin to arrive from the south early in March.

THE AMERICAN ROBIN
Group, Hall No. 308

List of
Principal Papers Relating to the Birds of the Vicinity of New York City.

1844. De Kay, J. E. Zoology of New York, or the New York Fauna; comprising detailed descriptions of all the animals hitherto observed within the State of New York, with brief notices of those occasionally found near its borders, and accompanied by appropriate illustrations. Part II, Birds. Albany: 1 Vol., 4 to, pp. xii, 380, pll. col'd, 141.

Treats of 308 species. "Though still constantly quoted—and properly to be referred to—it has ceased to be regarded as an authority" (Coues).

1844. Giraud, J. P., Jr. The Birds of Long Island....New York: published by Wiley & Putnam, 161 Broadway....1 Vol., 8vo., pp. i—xxiv, 1—397.

Treats of 286 species, giving descriptions and extended annotations. Only 200 copies of this work are supposed to have been placed in circulation.

1866. Lawrence, G. N. Catalogue of Birds observed on New York, Long, and Staten Island and the adjacent parts of New Jersey. Ann. Lyc. Nat. Hist., New York, VIII, pp. 279—300.

A partly annotated list of 327 species.

1868. Abbott, C. C. Catalogue of Vertebrate Animals of New Jersey. Cooke's Geology of New Jersey. Appendix E. Birds, pp. 761—798.

An annotated list of 301 species, abounding in errors and only to be used with discrimination.

1869. Turnbull, W. P. The Birds of East Pennsylvania and New Jersey. Glasgow, Printed for Private Circulation.

1876. Bicknell, E. P. Field Notes at Riverdale. Forest and Stream, VI, p. 233; also pp. 133, 148, 386, 402.

Winter and spring notes on numerous species.

1876. Stevens, W. G. Bird arrivals on the Harlem. Forest and Stream, VI, p. 215.

Notes on 40 species.

1877. Merriam, C. Hart. A Review of the Birds of Connecticut with Remarks on Their Habits. Trans. Conn. Acad., IV, pp. 1—165.

A fully annotated list of 292 species.

1877. Stevens, W. B. [Arrivals of Birds at West Farms, N. Y., during the springs of 1874, 1875, and 1876.] Forest and Stream, VIII, p. 400.

Dates of arrival of 32 species.

1878. Benner, F. Bird Notes from Long Island. Forest and Stream, X, pp. 174, 215.

Notes from Astoria on a number of species.

1878. Bicknell, E. P. Evidences of the Carolinian Fauna in the Lower Hudson Valley, Principally from Observations taken at Riverdale, N. Y. Bull. Nutt. Orn. Club, III, pp. 128—132.

On 13 Carolinian species. (See also Allen, J. A. *ibid.*, pp. 149, 150.)

1878. Huyler, A. I. Winter Birds on the Hackensack. The Country, I, p. 149.

1878. Lawrence, N. T. Notes on several rare Birds taken on Long Island. Forest and Stream, X, p. 235.

Notes on 24 species.

1878. Winkle, N. [Spring Birds at Summit, N. J.] The Country, II, p. 57.

1879. Coues, G. H. List of Birds observed in the Naval Hospital Grounds, in Brooklyn City. Bull. Nutt. Orn. Club, IV, pp. 31—33.

Brief notes on 60 species.

1879. Herrick, H. Notes on some Birds of Chatham, N. J. Forest and Stream, XII, p. 165.

1879—80. Mearns, E. A. A list of the Birds of the Hudson Highlands. Bull, Essex (Mass.) Inst., X, pp. 166—179; XI, 43—52, 154—168, 189—204; XII, 11—25, 109—128; XIII, 75—93.

One of the best and most complete of our local papers, treating fully of 209 species. (See also an Addendum adding 5 species in The Auk, VII, 1890, pp. 55, 56; also reviews in Bull. Nutt. Orn. Club, V, 1880, p. 175; VI, 1881, p. 172.)

1879. Nichols, G. N. Migration of some Warblers through Summit, N. J., during the last spring. Forest and Stream, XII, p. 464.

Notes on 18 species.

1879. Roosevelt, T. Notes on some of the Birds of Oyster Bay, Long Island. One-page leaflet, published by the author.

Notes on 17 species.

1879. Scott, W. E. D. Late Fall and Winter Notes on some Birds Observed in the Vicinity of Princeton, N. J., 1878—79. Bull. Nutt. Orn. Club, IV, pp. 81—85.

Notes on 35 species.

1879—85. Fisher, A. K. Occurrence of Several rare Birds near Sing Sing, N. Y. Bull. Nutt. Orn. Club, IV. pp. 61, 62.

Notes on 5 species. For additional notes by the same author on the rarer birds of Sing Sing, see *ibid.*, III, 1878, pp. 191, 192; IV, 1879, p. 234; VI, 1881, p. 245; VII, 1882, pp. 249, 251; VIII, 1883, pp. 121, 180; Auk, II, 1885, pp. 306, 378.

1880. Lawrence, R. Notes on some of the Rarer Birds of Long Island, N. Y. Bull. Nutt. Orn. Club, V, pp. 116, 117.

Notes on 8 species.

1880. Stearns, W. A. List of Birds of Fishkill-on-Hudson, N. Y. 8vo., pp. 16. Published by the author.

A briefly annotated list of 138 species. (Review in Bull. Nutt, Orn. Club, V, 1880, p. 233.)

1881. Berier, De L. Notes on a few Birds Observed at Fort Hamilton, Long Island, N. Y. Bull. Nutt. Orn. Club, VI, pp. 11—13.

Brief notes on 10 species.

1881. Berier, De L. Notes on Birds Rare or Accidental on Long Island, N. Y. Bull. Nutt. Orn. Club, VI, pp. 125, 126.

Notes on 11 species.

1882. Townsend, A. L. [Arrival of Birds in spring at Bay Ridge, L. I.] Forest and Stream, XVIII, pp. 305, 346, see also p. 427.

Notes on some 30 species.

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INDEX

ACANTHIS CANNABINA . . [65]
" *linaria* . . . . [64]
" *linaria rostrata* . . [64]
Accidental Visitants, list of . [14]
Accipiter cooperi . . . [46]
" *velox* . . . . [46]
Actitis macularia . . . [43]
Actodromas bairdi . . . [41]
" *fuscicollis* . . . [41]
" *maculata* . . . [41]
" *minutilla* . . . [41]
Ægialitis meloda . . . [44]
" *semipalmata* . . . [43]
Agelaius phœniceus . . . [59]
Aix sponsa . . . . [34]
Alauda arvensis . . . [56]
Alca torda . . . . [28]
Alle alle . . . . [28]
Ammodramus caudacutus . . [65]
" *henslowi* . . . [65]
" *maritimus* . . . [65]
" *nelsoni* . . . [65]
" *nelsoni subvirgatus* . . [65]
Ampelis cedrorum . . . [70]
" *garrulus* . . . [70]
Anas boschas . . . [33]
" *obscura* . . . [33]
" *obscura rubripes* . . [33]
Anser albifrons gambeli . . [37]
Anthus pensilvanicus . . [78]
Antrostomus vociferus . . [54]
Aquila chrysaëtos . . . [46]
Archibuteo lagopus sancti-johannis . . . . [46]
Ardea herodias . . . [37]
Ardetta exilis . . . [37]
Arenaria morinella . . [44]
Arquatella maritima . . [41]
Asio accipitrinus . . . [50]
" *wilsonianus* . . [49]
Astragalinus tristis . . [63]
Astur atricapillus . . [46]
Auk, Razor-billed . . . [28]
Avocet, American . . . [40]
Aythya affinis . . . [35]
" *americana* . . . [34]
" *collaris* . . . [35]
" *marila* . . . [35]
" *vallisneria* . . . [35]

BÆOLOPHUS BICOLOR . . [80]
Baldpate . . . . [34]
Bartramia longicauda . . [43]
Beetle-head . . . . [43]
Bittern, American . . . [37]
" Least . . . . [37]
Blackbird, Crow . . . . [60]
" Red-winged . . . [59]
" Rusty . . . . [60]
Bluebird . . . . [85]
Bobolink . . . . [59]
ob-white . . . . [44]
Bonasa umbellus . . . [44]
Booby . . . . [32]
Botaurus lentiginosus . . [37]
Brant, Black . . . [37]
" White-bellied . . [37]
Brantbird . . . . [44]
Branta bernicla glaucogaster . [37]
" *canadensis* . . . [37]
" *canadensis hutchinsi* . [37]
" *leucopsis* . . . [37]
" *nigricans* . . . [37]
Bubo virginianus . . . [53]
Bufflehead . . . . [35]
Bunting, Bay-winged . . [64]
" Black-throated . . [68]
" Indigo . . . . [68]
" Painted . . . [68]
" Snow . . . . [64]
Butcher-bird . . . [70]
Buteo borealis . . . [46]
" *platypterus* . . . [46]
" *lineatus* . . . [46]
" *swainsoni* . . . [46]
Butorides virescens . . [38]
Butterball . . . . [35]
Buzzard, Turkey . . . [45]

CALCARIUS LAPPONICUS . . [64]
" *ornatus* . . . [64]
Calico-back . . . . [44]
Calidris alba . . . . [42]
Camptolaimus labradorius . [35]
Canvas-back . . . [35]
Cardinal . . . . [68]
Cardinalis cardinalis . . [68]
Carduelis carduelis . . [63]
Carpodacus purpureus . . [62]
Catbird . . . . [78]
Catharista urubu . . . [45]
Cathartes aura septentrionalis . [45]
Catoptrophorus semipalmatus . [42]
" *semipalmatus inornatus* . [42]
Cedar-bird . . . . [70]
Centurus carolinus . . [54]
Ceophlœus pileatus abieticola . [53]
Cepphus grylle . . . [28]
Certhia familiaris americana . [70]
Ceryle alcyon . . . . [53]
Chætura pelagica . . . [54]
Chaffinch . . . . [62]
Charadrius dominicus. . . [43]

Charitonetta albeola . . . [35]
Chat, Yellow-breasted . . [77]
Chaulelasmus streperus . . [33]
Chen hyperborea nivalis . . [36]
Chewink . . . . . [68]
Chickadee . . . . . [81]
" Carolina . . . . [81]
Chloris chloris . . . . [62]
Chondestes grammacus . . [65]
Chordeiles virginianus . . [54]
Circus hudsonius . . . . [45]
Cistothorus stellaris . . [74]
Clangula clangula americana . [35]
Clape . . . . . [54]
Coccyzus americanus . . . [53]
" *erythrophthalmus* . . [53]
Colaptes auratus luteus . . [54]
Colinus virginianus . . . [44]
Columbigallina passerina terrestris . . . . . [45]
Colymbus auritus . . . [27]
" *holbœlli* . . . . [27]
Compsothlypis americana usneæ . [72]
Coot, American . . . . [39]
" Black . . . . . [36]
" White-winged . . . [36]
Cormorant . . . . . [33]
" Double-crested . . . [33]
Corvus brachyrhynchos . . [57]
" *corax principalis* . . [57]
" *ossifragus* . . . . [57]
Coturnicops noveboracensis . . [39]
Coturniculus savannarum passerinus . . . . . [65]
Cowbird . . . . . [59]
Crake, Corn . . . . . [39]
Crane . . . . . [37]
Creciscus jamaicensis . . . [39]
Creeper, Brown . . . . [80]
Crex crex . . . . . [39]
Crossbill, American . . . [62]
" White-winged . . . [62]
Crow, American . . . . [39]
" Fish . . . . . [57]
Crymophilus fulicarius . . [39]
Cryptoglaux acadica . . . [50]
Cuckoo, Black-billed . . . [53]
" Yellow-billed . . . [53]
Curlew, Eskimo . . . . [43]
" Hudsonian . . . . [43]
" Jack . . . . . [43]
" Long-billed . . . . [43]
Cyanocitta cristata . . . [53]
Cyanospiza ciris . . . . [68]
" *cyanea* . . . . . [68]

Dabchick . . . . . [27]
Dafila acuta . . . . . [34]
Dendroica æstiva . . . . [72]
" *blackburniæ* . . . . [73]
" *cerulea* . . . . . [73]
" *cærulescens* . . . [73]
" *castanea* . . . . [73]
" *coronata* . . . . [73]
" *discolor* . . . . [74]
" *dominica* . . . . [74]
" *maculosa* . . . . [73]
" *palmarum* . . . . [74]
" *palmarum hypochrysea* . [74]
" *pensylvanica* . . . [73]
" *striata* . . . . . [73]
" *tigrina* . . . . . [72]
" *vigorsi* . . . . . [74]
" *virens* . . . . . [74]
Dickcissel . . . . . [68]
Die-Dapper . . . . . [27]
Dolichonyx oryzivorus . . [59]
Dough-bird . . . . . [43]
Dove, Ground . . . . . [45]
" Mourning . . . . [45]
Dovekie . . . . . [28]
Dowitcher . . . . . [41]
" Long-billed . . . . [41]
Dryobates borealis . . . [53]
" *pubescens medianus* . [53]
" *villosus* . . . . [53]
Duck, American Scaup . . [35]
" Black . . . . . [33]
" Crow . . . . . [39]
" Harlequin . . . . [35]
" Labrador . . . . [35]
" Lesser Scaup . . . [35]
" Raft . . . . . [35]
" Red-legged Black . . [33]
" Ring-necked . . . [35]
" Ruddy . . . . . [36]
" Rufous-crested . . [34]
" Summer . . . . [34]
" Wood . . . . . [34]

Eagle, Bald . . . . . [46]
" Golden . . . . . [46]
Ectopistes migratorius . . [45]
Egret, American . . . . [38]
Egretta candidissima . . . [38]
Eider, American . . . . [36]
" King . . . . . [36]
Elanoides forficatus . . . [45]
Empidonax flaviventris . . [56]
" *minimus* . . . . [56]
" *trailli alnorum* . . [56]
" *virescens* . . . . [56]
Ereunetes mauri . . . . [42]
" *pusillus* . . . . [42]

Erismatura jamaicensis . . . [36]
Erolia ferruginea . . . . [42]
Euphagus carolinus . . . [60]

FALCO COLUMBARIUS . . . [49]
" *peregrinus anatum* . . [46]
" *rusticolus gyrfalco* . . [46]
" " *obsoletus* . . [46]
" *sparverius* . . . . [49]
Fauna, Alleghanian, southern limits of . . . . . [8]
" Carolinian, northern limits of . . . . . [8]
Finch, Grass . . . . . [64]
" Pine . . . . . [64]
" Purple . . . . . [62]
Flicker . . . . . [54]
Florida cærulea . . . . [38]
Flycatcher, Alder . . . . [56]
" Crested . . . . [55]
" Green-crested . . . [55]
" Least . . . . . [56]
" Olive-sided . . . . [55]
" Yellow-bellied . . . [56]
Fratercula arctica . . . [28]
Fringilla cælebs . . . . [62]
Fulica americana . . . . [39]
Fulmar . . . . . [31]
Fulmarus glacialis . . . [31]
Fute . . . . . [43]

GADWALL . . . . . [33]
Galeoscoptes carolinensis . . [78]
Gallinago delicata . . . . [41]
Gallinula galeata . . . . [39]
Gallinule, Florida . . . . [39]
" Purple . . . . . [39]
Gannet . . . . . [33]
Gavia arctica . . . . . [27]
" *imber* . . . . . [27]
" *lumme* . . . . . [27]
Gelochelidon nilotica . . . [30]
Geothlypis trichas brachidactyla . [77]
Gnatcatcher, Blue-gray . . [81]
Godwit, Hudsonian . . . [42]
" Marbled . . . . [42]
Golden-eye, American . . [35]
Goldfinch, American . . . [63]
" European . . . . [63]
Goose, American White-fronted [37]
" Barnacle . . . . [37]
" Canada . . . . [37]
" Greater Snow . . . [36]
" Hutchins's . . . . [37]
Goshawk, American . . . [40]
Grackle, Bronzed . . . . [60]
" Purple . . . . . [60]
Grebe, Holbœll's . . . . [27]
" Horned . . . . [27]
" Pied-billed . . . . [27]
Greenfinch . . . . . [62]
Grosbeak, Blue . . . . [68]
" Evening . . . . [60]
" Pine . . . . . [61]
" Rose-breasted . . . [68]
Grouse, Pinnated . . . . [44]
" Ruffed . . . . . [44]
Guara alba . . . . . [37]
Guillemot, Black . . . . [28]
Guiraca cærulea . . . . [68]
Gull, Bonaparte . . . . [29]
" Burgomaster . . . [29]
" Glaucous . . . . [29]
" Great Black-backed . . [29]
" Herring . . . . [29]
" Iceland . . . . [29]
" Ivory . . . . . [28]
" Kittiwake . . . . [29]
" Kumlien . . . . [29]
" Laughing . . . . [29]
" Little . . . . . [29]
" Ring-billed . . . . [29]
" Sabine . . . . . [30]
Gyrfalcon . . . . . [46]
" Black . . . . . [46]

HÆMATOPUS PALLIATUS . . [44]
Haliæetus leucocephalus . . [46]
Harelda hyemalis . . . . [35]
Hawk, American Rough-legged . [40]
" American Sparrow . [47]
" Broad-winged . . [46]
" Chicken . . . . [46]
" Cooper . . . . . [46]
" Duck . . . . . [46]
" Fish . . . . . [49]
" Hen . . . . . [46]
" Marsh . . . . . [45]
" Pigeon . . . . . [49]
" Red-shouldered . . . [46]
" Red-tailed . . . . [46]
" Sharp-shinned . . . [46]
" Swainson . . . . [46]
Hell-diver . . . . . [27]
Helminthophila celata . . . [72]
" *chrysoptera* . . . . [72]
" *lawrencei* . . . . [72]
" *leucobronchialis* . . . [71]
" *peregrina* . . . . [72]
" *pinus* . . . . . [71]
" *rubricapilla* . . . . [72]
Helmitheros vermivorus . . . [71]
Helodromas solitarius . . . [42]

Hen, Heath . . . . . [44]
" Marsh . . . . . [38]
" Meadow . . . . . [38]
" Mud . . . . . [39]
Herodias egretta . . . . [38]
Heron, Black-crowned Night . [38]
" Great Blue . . . . [37]
" Green . . . . . [38]
" Little Blue . . . . [38]
" Snowy . . . . . [38]
" Yellow-crowned Night . [38]
Hesperiphona vespertina . . [60]
High-hole . . . . . [54]
Himantopus mexicanus . . [40]
Hirundo erythrogaster . . [69]
Histrionicus histrionicus . . [35]
Horizopus virens . . . . [56]
Humming-bird, Ruby-throated . [55]
Hydrochelidon nigra surinamensis [31]
Hylocichla aliciæ . . . . [84]
" *aliciæ bicknelli* . . . [84]
" *fuscescens* . . . . [84]
" *guttata pallasi* . . . [84]
" *mustelina* . . . . [84]
" *ustulata swainsoni* . . [84]

Ibis, Glossy . . . . . [37]
" White . . . . . [37]
Icteria virens . . . . . [77]
Icterus galbula . . . . [60]
" *spurius* . . . . [60]
Ionornis martinica . . . [39]
Iridoprocne bicolor . . . [69]
Ixoreus nævius . . . . [84]

Jæger, Parasitic . . . . [28]
" Pomarine . . . . [28]
" Long-tailed . . . [28]
Jay, Blue . . . . . [57]
" Canada . . . . . [57]
Junco . . . . . [67]
Junco, hyemalis . . . . [67]

Kildeer . . . . . [43]
Kingbird . . . . . [55]
" Arkansas . . . . [55]
Kingfisher, Belted . . . [53]
Kinglet, Golden-crowned . . [81]
" Ruby-crowned . . . [81]
Kite, Swallow-tailed . . . [45]
Knot . . . . . [41]

Lanius borealis . . . . [70]
" *ludovicianus migrans* . . [70]
Lanivireo flavifrons . . . [70]
Lanivireo, solitarius . . . [70]
Lapwing . . . . . [43]
Lark, Horned . . . . [56]
" Prairie Horned . . . [56]
" Shore . . . . . [56]
Larus argentatus . . . . [29]
" *atricilla* . . . . . [29]
" *delawarensis* . . . [29]
" *glaucus* . . . . . [29]
" *kumlieni* . . . . [29]
" *leucopterus* . . . . [29]
" *marinus* . . . . [29]
" *minutus* . . . . [29]
" *philadelphia* . . . . [29]
Limosa fedoa . . . . [42]
" *hæmastica* . . . . [42]
Linnet . . . . . [63]
Longspur, Chestnut-colored . . [64]
" Lapland . . . . [64]
Loon . . . . . [27]
" Black-throated . . . [27]
" Red-throated . . . [27]
Lophodytes cucullatus . . [33]
Loxia curvirostra minor . . [62]
" *leucoptera* . . . . [62]

Macrorhamphus griseus . [41]
" *scolopaceus* . . . [41]
Mallard . . . . . [33]
Mareca americana . . . . [34]
" *penelope* . . . . [33]
Marlin, Brown . . . . [42]
" Ring-tailed . . . . [42]
Martin, Purple . . . . [69]
Meadowlark . . . . . [59]
Megascops asio . . . . [50]
Melanerpes erythrocephalus . . [53]
Meleagris gallopavo silvestris . [44]
Melospiza cinerea melodia . . [67]
" *georgiana* . . . . [67]
" *lincolni* . . . . [67]
Merganser americanus . . . [33]
" *serrator* . . . . [33]
Merganser, American . . . [33]
" Hooded . . . . [33]
" Red-breasted . . . [33]
Merula migratoria . . . [84]
Micropalama himantopus . . [41]
Mimus polyglottos . . . [78]
Mniotilta varia . . . . [71]
Mockingbird . . . . . [78]
Molothrus ater . . . . [59]
Murre, Brunnich's . . . [28]
Myadestes townsendi . . . [84]
Myiarchus crinitus . . . . [55]

INDEX

NETTA RUFINA . . . . [34]
Nettion carolinensis . . . [34]
" *crecca* . . . . . [34]
Nighthawk . . . . . [54]
Numenius borealis . . . [43]
" *hudsonicus* . . . . [43]
" *longirostris* . . . . [43]
Nuthatch, Red-breasted . . [80]
" White-breasted . . . [80]
Nuttallornis borealis . . . [55]
Nyctanassa violacea . . . [38]
Nyctea nyctea . . . . [53]
Nycticorax nycticorax nævius . [38]

OCEANITES OCEANICUS . . [32]
Oceanodroma leucorhoa . . [32]
Ochthodromus wilsonius . . [44]
Oidemia americana . . . [36]
" *deglandi* . . . . [36]
" *perspicillata* . . . . [36]
Olbiorchilus hiemalis . . . [80]
Old-Squaw . . . . . [35]
Old-Wife . . . . . [35]
Olor columbianus . . . [37]
Oporornis agilis . . . . [77]
" *formosa* . . . . . [77]
" *philadelphia* . . . . [77]
Oriole, Baltimore . . . . [60]
" Orchard . . . . [60]
Osprey, American . . . . [47]
Otocoris alpestris . . . [56]
" *alpestris praticola* . . [56]
Ovenbird . . . . . [74]
Owl, American Barn . . . [49]
" American Long-eared . . [49]
" Barred . . . . . [50]
" Great Gray . . . . [50]
" Great Horned . . . [53]
" Hawk . . . . . [53]
" Saw-whet . . . . [50]
" Screech . . . . [50]
" Short-eared . . . . [50]
" Snowy . . . . . [53]
Oxeye, Meadow . . . . [41]
" Sand . . . . . [42]
Oxyechus vociferus . . . [43]
Oyster-catcher . . . . [44]

PAGOPHILA ALBA . . . [28]
Pandion haliaëtus carolinensis . [49]
Partridge . . . . . [44]
Passer domesticus . . . [61]
Passerculus princeps . . . [64]
" *sandwichensis savanna* . . [64]
Passerella iliaca . . . . [67]
Passerina nivalis . . . . [64]
Pavoncella pugnax . . . [42]
Peep . . . . . [41, 42]
Pelecanus erythrorhynchos . . [33]
" *occidentalis* . . . . [33]
Pelican, Brown . . . . [33]
" White . . . . . [33]
Pelidna alpina sakhalina . . [41]
Penthestes atricapillus . . . [81]
" *carolinensis* . . . . [81]
Perisoreus canadensis . . . [57]
Permanent Residents, List of . [9]
Petrel, Leach . . . . . [32]
" Stormy . . . . . [32]
" Wilson's . . . . . [32]
Petrochelidon lunifrons . . [69]
Pewee, Wood . . . . [56]
Phalacrocorax auritus . . . [33]
" *carbo* . . . . . [33]
Phalarope, Northern . . . [39]
" Red . . . . . [39]
" Wilson's . . . . [39]
Phalaropus lobatus . . . [39]
Philohela minor . . . . [40]
Phœbe . . . . . [55]
Pigeon, Passenger . . . . [45]
" Wild . . . . . [45]
Pinicola enucleator leucura . . [61]
Pintail . . . . . [34]
Pipilo erythrophthalmus . . [68]
Pipit, American . . . . [78]
Piranga erythromelas . . . [69]
" *ludoviciana* . . . [68]
" *rubra* . . . . . [69]
Plegadis autumnalis . . . [37]
Plover, American Golden . . [43]
" Black-bellied . . . [43]
" Field . . . . . [43]
" Piping . . . . . [44]
" Semipalmated . . . [43]
" Upland . . . . . [43]
" Wilson's . . . . [44]
Podilymbus podiceps . . . [27]
Polioptila cærulea . . . [81]
Poœcetes gramineus . . . [64]
Porzana carolina . . . . [38]
Procellaria pelagica . . . [32]
Progne subis . . . . [69]
Protonotaria citrea . . . [71]
Puffin . . . . . [28]
Puffinus borealis . . . . [31]
" *gravis* . . . . . [32]
" *griseus* . . . . . [32]
" *lherminieri* . . . . [32]

QUAIL . . . . . [44]
Querquedula discors . . . [34]
Quiscalus quiscula . . . [60]
" *quiscula æneus* . . . [60]

Rail, Black . . . . . [39]
" Carolina . . . . . [38]
" Clapper . . . . . [38]
" King . . . . . [38]
" Virginia . . . . . [38]
" Yellow . . . . . [39]
Rallus crepitans . . . . . [38]
" *elegans* . . . . . [38]
" *virginianus* . . . . . [38]
Raven, American . . . . . [57]
Recurvirostra americana . . [40]
Redhead . . . . . [34]
Redpoll . . . . . [62]
" Greater . . . . . [62]
Redstart, American . . . [78]
Reedbird . . . . . [59]
Regulus calendula . . . . . [81]
" *satrapa* . . . . . [81]
Riparia riparia . . . . . [69]
Rissa tridactyla . . . . . [29]
Robin, American . . . . . [84]
Ruff . . . . . [42]
Rynchops nigra . . . . . [31]

Sanderling . . . . . [42]
Sandpiper, Baird . . . . . [41]
" Bartramian . . . . . [43]
" Buff-breasted . . . . . [43]
" Curlew . . . . . [42]
" Least . . . . . [41]
" Pectoral . . . . . [41]
" Purple . . . . . [41]
" Red-backed . . . . . [41]
" Semipalmated . . . . . [42]
" Solitary . . . . . [42]
" Spotted . . . . . [43]
" Stilt . . . . . [41]
Sandpiper, Western . . . [42]
" White-rumped . . . [41]
Sapsucker, Yellow-bellied . . [46]
Saxicola œnanthe leucorhoa . [84]
Sayornis phœbe . . . . . [55]
Scolopax rusticola . . . [40]
Scoter, American . . . . [36]
" Surf . . . . . [36]
" White-winged . . . [36]
Scotiaptex nebulosa . . . [50]
Seiurus aurocapillus . . . [74]
" *motacilla* . . . . . [74]
" *noveboracensis* . . . [74]
" *noveboracensis notabilis* . [77]
Setophaga ruticilla . . . [78]
Shearwater, Audubon . . . [32]
" Cory . . . . . [31]
" Greater . . . . . [32]
" Sooty . . . . . [32]
Shelldrake . . . . . [33]
Shoveller . . . . . [34]
Shrike, Migrant . . . . . [70]
" Northern . . . . . [70]
Sialia sialis . . . . . [85]
Sickle-bill . . . . . [43]
Siskin, Pine . . . . . [64]
Sitta canadensis . . . . . [80]
" *carolinensis* . . . . . [80]
Skimmer, Black . . . . . [31]
Skylark . . . . . [56]
Snipe, English . . . . . [41]
" Surf . . . . . [42]
" Wilson's . . . . . [41]
Snowbird . . . . . [67]
Snowflake . . . . . [64]
Solitaire, Townsend . . . [84]
Somateria dresseri . . . [36]
" *spectabilis* . . . . . [36]
Sora . . . . . [38]
South-southerly . . . . . [35]
Sparrow, Acadian Sharp-tailed . [65]
" Chipping . . . . . [67]
" English . . . . . [61]
" Field . . . . . [67]
" Fox . . . . . [67]
" Grasshopper . . . . . [65]
" Henslow . . . . . [65]
" House . . . . . [61]
" Ipswich . . . . . [64]
" Lark . . . . . [65]
" Lincoln . . . . . [67]
" Nelson . . . . . [65]
" Savanna . . . . . [64]
" Seaside . . . . . [65]
" Sharp-tailed . . . . . [65]
" Song . . . . . [67]
" Swamp . . . . . [67]
" Tree . . . . . [66]
" Vesper . . . . . [64]
" White-crowned . . . [66]
" White-throated . . . [66]
" Yellow-winged . . . [65]
Spatula clypeata . . . . . [34]
Sphyrapicus varius . . . . [53]
Spinus pinus . . . . . [64]
Spiza americana . . . . . [68]
Spizella monticola . . . . [66]
" *pusilla* . . . . . [67]
" *socialis* . . . . . [67]
Spoonbill . . . . . [34]
Sprigtail . . . . . [34]
Squatarola squatarola . . . [43]
Starling . . . . . [58]
Steganopus tricolor . . . [39]
Stelgidopteryx serripennis . [69]
Stercorarius longicaudus . . [28]
" *parasiticus* . . . . . [28]
" *pomarinus* . . . . . [28]

Sterna antillarum [31]
" *caspia* [30]
" *dougalli* [30]
" *fuliginosa* [31]
" *hirundo* [30]
" *maxima* [30]
" *paradisæa* [30]
Stilt, Black-necked [40]
Strix pratincola [49]
Sturnella magna [59]
Sturnus vulgaris [58]
Sula bassana [33]
" *leucogaster* [32]
Summer Residents, List of [10]
Summer Visitants, List of [11]
Surnia ulula caparoch [53]
Swallow, Bank [69]
" Barn [69]
" Cliff [69]
" Rough-winged [69]
" Sea [30]
" Tree [69]
Swan, Whistling [37]
Swift, Chimney [54]
Syrnium varium [50]

Tanager, Louisiana [68]
" Scarlet [69]
" Summer [69]
" Western [68]
Teal, Blue-winged [34]
" European Green-winged [34]
" Green-winged [34]
Telmatodytes palustris [80]
Tern, Arctic [30]
" Black [31]
" Caspian [30]
" Common [30]
" Forster's [30]
" Gull-billed [30]
" Least [31]
" Roseate [30]
" Royal [30]
" Sooty [31]
Thrasher, Brown [78]
Thrush, Bicknell's [84]
" Gray-cheeked [84]
" Hermit [84]
" Olive-backed [84]
" Varied [84]
" Wilson's [84]
" Wood [84]
Thryothorus ludovicianus [70]
Tip-up [43]
Titlark [78]
Titmouse, Tufted [80]
Totanus flavipes [42]
" *melanoleucus* [42]
Towhee [68]
Toxostoma rufum [78]
Transient Visitants, Irregular, List of [13]
Transient Visitants, Regular, List of [12]
Tringa canutus [41]
Trochilus colubris [55]
Troglodytes ædon [79]
Tryngites subruficollis [43]
Turkey, Wild [44]
Turnstone [44]
Tympanuchus cupido [44]
Tyrannus tyrannus [55]
" *verticalis* [55]

URIA LOMVIA [28]

VANELLUS VANELLUS [43]
Veery [84]
Vireo noveboracensis [70]
Vireo, Blue-headed [70]
" Philadelphia [70]
" Red-eyed [70]
" Warbling [70]
" White-eyed [70]
" Yellow-throated [70]
Vireosylva gilva [70]
" *olivacea* [70]
" *philadelphica* [70]
Vulture, Black [45]
" Turkey [45]

Warbler, Bay-breasted [73]
" Black and White [71]
" Blackburnian [73]
" Black-poll [73]
" Black-throated Blue [73]
" Black-throated Green [74]
" Blue-winged [71]
" Brewster's [71]
" Canadian [78]
" Cape May [72]
" Cerulean [73]
" Chestnut-sided [73]
" Connecticut [77]
" Golden-winged [72]
" Hooded [78]
" Kentucky [77]
" Lawrence's [72]
" Magnolia [73]
" Mourning [77]
" Myrtle [73]
" Nashville [72]
" Orange-crowned [72]
" Palm [74]
" Parula [72]
" Pine [74]

Warbler, Prairie . . . . [74]
" Prothonotary . . . [71]
" Tennessee . . . . [72]
" Wilson's . . . . [78]
" Worm-eating . . . [71]
" Yellow . . . . . [72]
" Yellow-palm . . . . [74]
" Yellow-rumped . . . [73]
" Yellow-throated . . . [74]
Water-Thrush . . . . [77]
" Grinnell's . . . . [77]
" Louisiana . . . . [77]
Waxwing, Bohemian . . . [70]
" Cedar . . . . . [70]
Wheatear . . . . . [84]
Whip-poor-will . . . . [54]
Whistler . . . . . [35]
Widgeon, American . . . [34]
" European . . . . [33]
Willet . . . . . [42]
" Western . . . . [42]
Wilsonia canadensis . . . [78]
" *mitrata* . . . . [78]
" *pusilla* . . . . [78]
Winter Residents, List of . . [11]
" Visitants, List of . . . [11]
Woodcock, American . . . [40]
" European . . . . [40]
Woodpecker, Downy . . . [53]
" Hairy . . . . . [53]
" Pileated . . . . [53]
" Red-bellied . . . . [54]
" Red-cockaded . . . [53]
" Red-headed . . . . [53]
" Yellow-bellied . . . [53]
Wren, Carolina . . . . [79]
" House . . . . . [79]
" Long-billed Marsh . . [80]
" Short-billed Marsh . . [80]
" Winter . . . . . [80]

XEMA SABINI . . . . [30]

YELLOW-LEGS . . . . [42]
" Greater . . . . [42]
" Summer . . . . [42]
Yellow-throat Maryland . . [77]
" Northern . . . . [77]

ZAMELODIA LUDOVICIANA . . [68]
Zenaidura macroura . . . [45]
Zonotrichia albicollis . . . [66]
" *leucophrys* . . . . [66]

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ERRATA.

The Editor regrets the occurrence of the following errors in this Guide, which of necessity was printed in the absence of the author:

Page 85, line 39 for Woodcocks read Woodcock.
" 88, " 7 " Black Gyrfalcon ? read Gyrfalcon.
" 90, " 6 " White Gyrfalcon " Black Gyrfalcon.
" 138, " 5 " *Iherminieri* " *l'herminieri.*
" 143, " 1 " *albiferons* " *albifrons.*
" 143, " 28 " *Gura* " *Guara.*
" 145, " 1 " *Colurnicops* " *Coturnicops.*
" 145, " 5, omit "See group, third floor."
" 149, " 37 for Kildeer read Killdeer.
" 150, " 14 " *pallitus* " *palliatus.*
" 152, " 14 " Swaison's " Swainson's.
" 152, " 27 " *Haliætus* " *Haliæetus.*
" 159, " 21 " Family ALCEDINIDÆ. Kingfishers read — Family PICIDÆ. Woodpeckers.
" 175, " 11 for *Progue* read *Progne.*
" 179, " 40 " *domina* " *dominica.*
" 183, " 11 " *Opornis* " *Oporornis.*
" 184, " 11 " *Steophaga* " *Setophaga.*
" 187, " 25 " *mustclina* " *mustelina.*
" 188, " 8 " *Hylocichla bicknelli* read *Hylocichla aliciæ bicknelli.*

Prefix the asterisk [*], indicating occurrence in Central Park, to the following species:

Screech Owl,
Northern Water-Thrush,
Louisiana Water-Thrush,
Yellow-breasted Chat,
Wilson's Thrush,
Gray-cheeked Thrush,
Olive-backed Thrush,
Hermit Thrush,
American Robin,
Bluebird.

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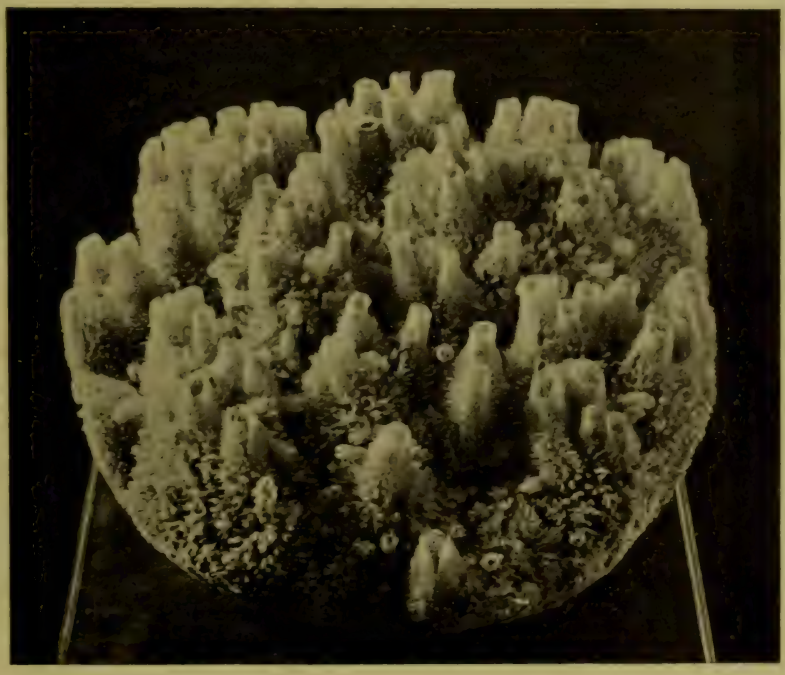

By Roy Waldo Miner

Assistant Curator of Invertebrate Zoölogy

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Guide Leaflet No. 23

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A GROUP OF LARGE BAHAMA SPONGES

The sponge in front measures 2 feet across. The upper specimen has grown around a tree-like colony of *Gorgonia*, a branching Hydroid. The peculiar chair-like shape of the specimen at the left is noteworthy.

A Guide

to the

Sponge Alcove

in the

American Museum of Natural History

By

ROY WALDO MINER

Assistant Curator of Invertebrate Zoölogy

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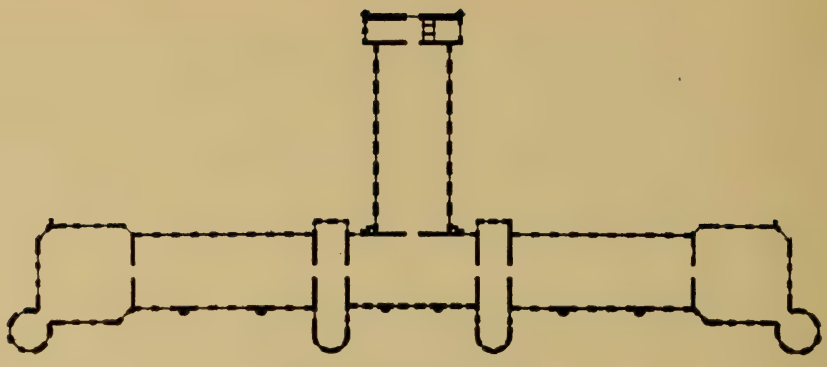


THIRD, OR GALLERY FLOOR.

Key-plan of the Museum building, showing the location of the hall in which the specimens may be found to which references are made in this Guide Leaflet

CONTENTS

	PAGE
General Characteristics of Sponges	219
Anatomy	220
1. General Structure	222
2. The Canal Systems	224
(a) The Ascon Type	225
(b) The Sycon Type	225
(c) The Rhagon Type	226
3. The Skeleton	228
Reproduction and Development	231
Physiology	233
Position of Sponges in the Animal Kingdom	234
Classification	234
Typical Sponges in the Museum	238
A. Calcareous Sponges	238
Homocœlida	238
Heterocœlida	238
B. Non-Calcareous Sponges	238
Hexactinellida	240
Tetractinellida	242
Monaxonida	242
Monoceratida	246
The Commercial Sponges	247

A GUIDE TO THE SPONGE ALCOVE IN THE AMERICAN MUSEUM OF NATURAL HISTORY.[1]

By Roy Waldo Miner,

Assistant Curator Department of Invertebrate Zoölogy.

PONGES are among the most abundant and most widely distributed of sea-animals. With the exception of one family, the fresh-water sponges, they are found in all seas of the globe ranging from shallow waters to beyond a depth of 1,300 feet. The bath-sponges of commerce, with which the word "sponge" is associated in the minds of most people, although from a commercial point of view the most important of the group, form but a single family, *i. e.*, the Spongidæ. The rest of the subkingdom with its great multiplicity of forms is doubtless comparatively unknown to the average person. Even the commercial sponge as it reaches us gives but little idea of what a sponge really is, as it is only the supporting or skeletal part of the animal colony denuded of its fleshy coat of living tissue.

The living sponge is either a single animal or a colony of animals. It is always sessile, that is, attached to the sea bottom, and incapable of locomotion. For this reason it has often been regarded as a plant. But since, in more recent years, its life processes and larval history have become better known, especially since it has come under the eye of the compound microscope, its animal nature has become clearly established.

Sponges show all variations of form, size, and color. There are cake-like sponges, dome-shaped sponges, and fan-shaped sponges. Some are branched like trees; in others the branches reunite to form a complicated network. Some are shaped like huge cups or goblets; some gather in clusters of trumpet- and

[1] Issued also in separate form as Guide Leaflet No 23.

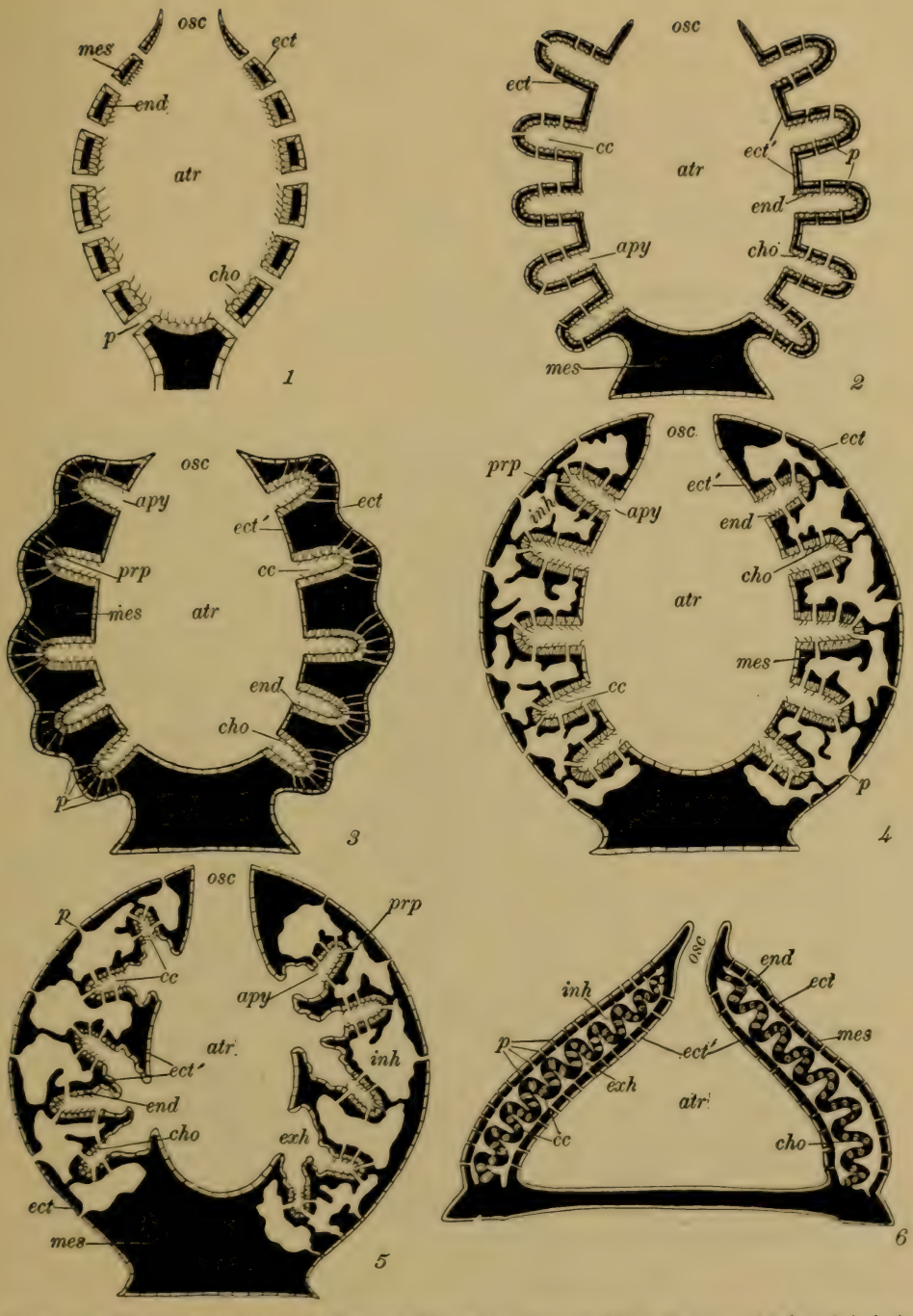
tube-like forms, and even the simplest and most primitive sponges are often shaped like graceful vases. All these forms are found in sizes varying from that of a pinhead to the height of a man.

Their color is as varied as their shape and size. They run through the whole chromatic scale from brilliant red, yellow, and green to the most delicate blue and the deepest violet, in every gradation of shade and tint. Some are pure white, others are shining black, while still others reflect from their opal spicules all the colors of the rainbow.

As the form and color of sponges, however, may vary as much among members of the same species as among those of different species these factors cannot be depended on for classification. The same sponge which in deep water shows the branching habit, in shallower water appears as a flat encrusting colony; or a sponge which has a symmetrical vase-like form, many feet below the surface of the sea, where it is little disturbed by outer influences, may be of the same species as an irregular one-sided mass growing in shallow water or in the crevice of a rock. Again a sponge usually dome-shaped may send out a finger-like process from its upper surface which becomes branched and unites with the branches of other finger-like processes. In other words external form in sponges is not a constant or essential factor. It is purely a matter of environment, in which gravity plays an important part. This tendency to vary has made the arrangement of sponges in an orderly and natural system, a difficult task, much complicated by the fact that for many years classification has been wrongly based upon these very factors. Since, however, the microscope has been developed to its present perfection, it has been found that the arrangement of the skeleton and the form of the spicules or skeletal units, together with the structure of the canal system, furnish more constant data for classification. This can be brought out more clearly in discussing the anatomy of the sponge.

ANATOMY.

In considering the anatomy of sponges it is sufficient for our purpose to concern ourselves with:



FIGS 1.—6—DIAGRAMS ILLUSTRATING CANAL SYSTEMS IN DIFFERENT TYPES OF SPONGES (after Schulze).

1 Ascon type ; 2–5. Variations of Sycon type ; 6. Rhagon type ; *ect.*, ectoderm of exterior; *ect'*, ectoderm of atrial cavity ; *mes.*, mesoderm ; *end.*, endoderm ; *osc.*, osculum; *atr.*, atrial cavity or cloaca ; *cho.*, choanocyte layer ; *cc.*, flagellate chambers ; *p.*, pores ; *prp.*, prosopyles ; *apy.*, apopyles ; *inh.*, inhalent cavities; *exh.*, exhalent cavities.

1. General Structure,
2. The Canal Systems,
3. The Skeleton.

1. *General Structure.*

This is best shown by the description of a simple sponge in which the general characteristics of the subkingdom predominate, unmodified by special conditions.

FIG. 7.—AN EXAMPLE OF THE BRANCHING HABIT

The simplest, most primitive, and at the same time most typical sponge is *Ascetta primordialis*, first described by Häckel

(See Fig. 1.). This sponge is typically vase-like in external form. The circular opening at the top of the vase is known as the *osculum* (*osc.*) in spite of the fact that it is excretory and has neither structurally nor functionally the characteristics of a mouth.

The walls of the vase are perforated with numerous regularly arranged openings or pores (*p.*) which open directly into the hollow interior of the sponge—called the *paragastric* or *atrial cavity* (*atr.*). The walls are made up of three layers: 1st, the ectoderm, or outer layer; 2d, the endoderm, or inner layer; 3d, the mesoderm, or middle layer.

The *ectoderm* (*ect.*) is a thin layer of cells, generally arranged in mosaic form and known as "pavement cells." In the case of this species, however, the walls of the cells have disappeared and left the protoplasmic cell-contents continuous over the entire surface of the animal. Such a layer is called a *syncytium.*

The *endoderm* (*end.*) lines the paragastric cavity and is made up of a layer of peculiar and characteristic cells called "collared cells," or *choanocytes* (*cho.*), found nowhere else among many-celled animals. They are so called from a collar-like rim around the outer edge of the cell out of which extends a long whip-like

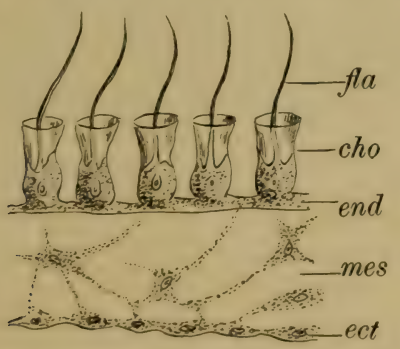


FIG. 8.—SECTION THROUGH SPONGE WALL

ect., ectoderm ; *mes.*, mesoderm ; *end.*, endoderm ; *cho.*, choanocytes or "collared cells"; *fla.*, flagellum.

filament or *flagellum* (*fla.*). The continuous vibration of these flagella produces a current by means of which the sea-water, with its multitude of tiny animal and plant forms, is sucked in through the pores. The organisms are then seized upon by the

choanocytes and their digestible parts absorbed. What is left is discarded and flows with the current out through the osculum at the summit of the vase.

The *mesoderm* (*mes.*) is a thin jelly-like layer between the ectoderm and endoderm. It contains scattered amœboid cells and the reproductive elements, and is the origin of the skeleton.

2. *The Canal Systems.*

In the form of sponge just described the mesoderm is extremely thin, but if, as in the majority of sponges, there is a greater or less thickening of this layer, the pores will no longer be perforations, but will become transformed into tubes or canals

FIG. 9.—A SYCON SPONGE (*Grantia ciliata* Fleming) GROWING ON A MUSSEL SHELL
Star-shaped colonies of the Ascidian *Botryllus* are also growing on the same shell.

(See p. 221, Fig. 3), which may branch and be modified in various ways. This gives rise to three general types of sponges which are therefore based mainly on the arrangement and variations of the pore- and canal-systems. These are known as

(a) The Ascon Type,
(b) The Sycon Type,
c) The Rhagon Type.

(a) *The Ascon Type* (p. 221, Fig 1.). This type is characterized by sponges having walls with a thin layer of mesodermal tissue (*mes.*), and therefore, with pores (*p.*) opening directly from the outside into the paragastric cavity (*atr.*). The endoderm (*end.*) is always continuously lined with choanocytes or "collared cells" (*cho.*). *Ascetta primordialis*, therefore, is the representative of this group. Another example is *Leucosolenia*, of which a specimen may be seen in this alcove. A complication of this type is shown by *Homoderma*, which differs from *Ascetta* in having its surface broken up by a multitude of radially arranged thimble-like prolongations or diverticula, each with a central cavity of its own, opening into the main paragastric cavity of the sponge and lined with a continuation of the endoderm with its collared cells. In this case the pores are found only in the walls of the diverticula.

(b) *The Sycon Type* (p. 221, Figs. 2–5; p. 224, Fig. 9). In this type, as in the example just described (*Homoderma*), the walls of the paragastric cavity are prolonged into radially arranged branches called *radial tubes* (*cc.*) but the choanocytes, instead of lining both the paragastric cavity and the radial tubes, are found only in the latter, while the former is invested with a layer of epidermal "pavement cells" (*ect.*) like the outside of the sponge. The mouth of the radial tube by which it opens into the central cavity is called the *apopyle* (*apy.*). In the simpler sponges of the Sycon type, such as *Sycon ciliatum*, the pores open directly into the radial tubes (Fig. 2) and the outer surface of the sponge is covered with papillæ corresponding to the cavities within. In these forms, the mesoderm (*mes.*) continues to be thin. In other forms, however, the mesoderm becomes greatly thickened and completely fills the spaces between the radial tubes (Fig. 3) so that the outer surface appears comparatively smooth and free from papillæ. Under these circumstances the pores cannot open directly from the outside into the radial tubes, so they lengthen into *inhalent canals* traversing the mesoderm. In still other forms (Fig. 4) the canals have enlarged to wide cavities or *inhalent lacunæ* (*inh.*) opening to the outside by the pores and into the radial tubes by openings called *prosopyles* (*prp.*). Another complication occurs in the Leucons where the walls of the para-

gastric cavity become folded in such a manner that the radial tubes lose their radial position and open into the folds or their branches (Fig. 5, *cc.*). The openings by which the folds communicate with the paragastric cavity may then become narrowed and thus large irregular spaces called *exhalent lacunæ* (*exh.*) are formed, with the result that the radial tubes become mere tubular chambers (*cc.*) communicating at the open end with the paragastric cavity (*atr.*) only by the intervention of the inhalent lacunæ (*inh.*), which in turn communicate with the outside by the pores. As both the inhalent and exhalent lacunæ are lined

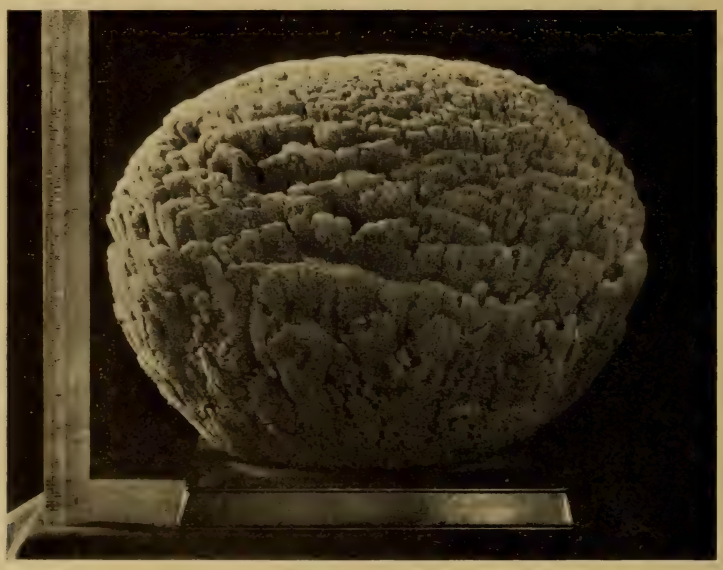


FIG. 10.—A LARGE BAHAMAN SPONGE (*Hippospongia cerebriformis* D. & M.)

with "pavement cells" (*ect.*) the choanocytes become restricted to the tubular *flagellate chambers*, as the radial tubes are now called.

(c) *The Rhagon Type* (p. 221, Fig, 6). The two preceding types of canal arrangement are peculiar to the sponges having a calcareous or carbonate of lime skeleton. The great majority of sponges, including those having "glass" skeletons, horny skeletons or no skeletons at all, belong to the Rhagon type. In this case the flagellate chambers (*cc.*) are very small and numerous and, instead of being tubular, are spherical. The mesoderm varies

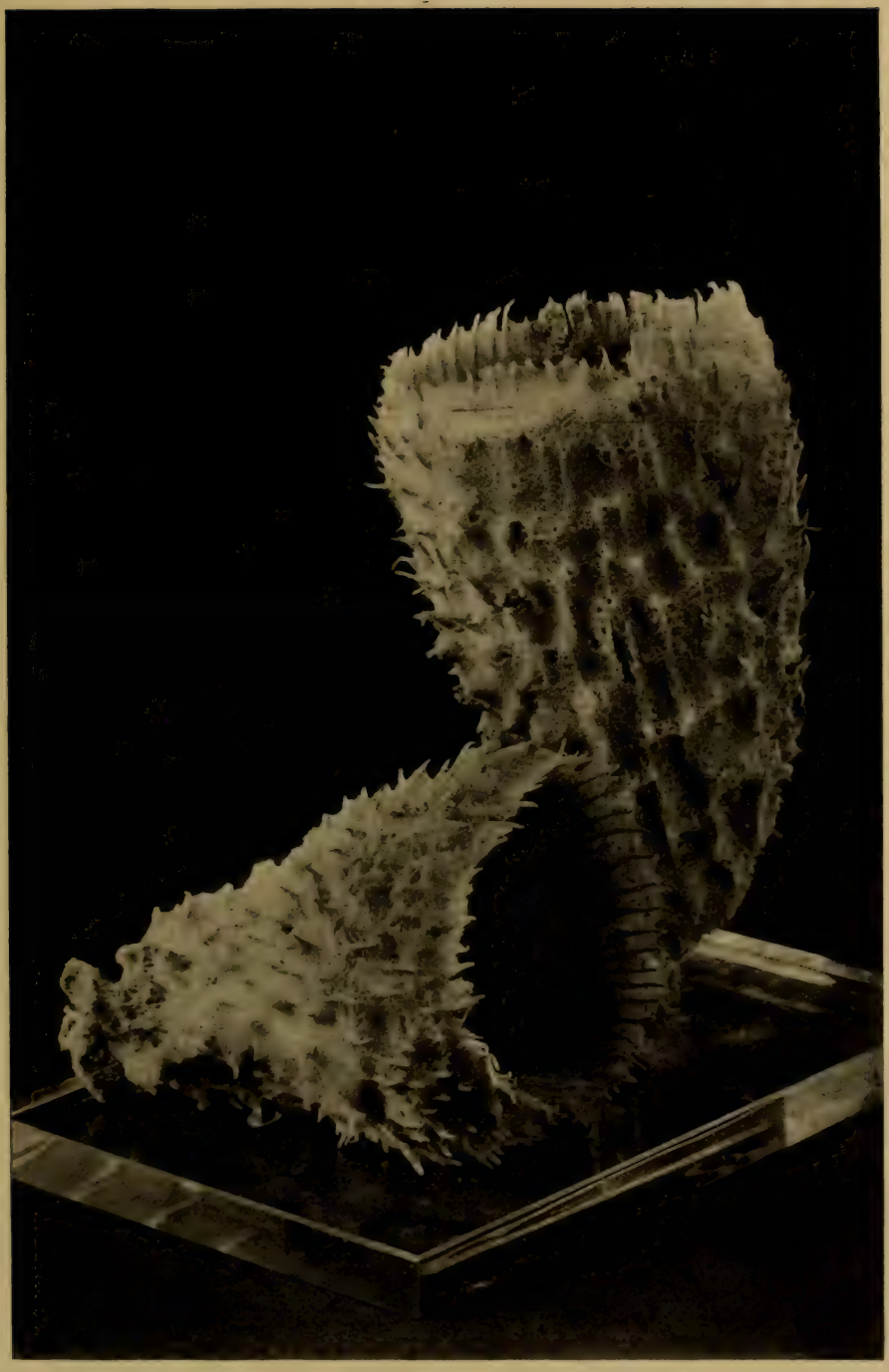


FIG. 11.—NON-COMMERCIAL HORNY SPONGES (*Stelospongia* sp.)
A trumpet-like form showing plainly the *principal fibers* projecting around the rim, and the *oscula* or excurrent openings lining the cavity of the specimen.

greatly in thickness, and the canal system may become much complicated through the folding of the walls of the paragastric cavity and the development of wide mesodermal cavities (*inh.* and *exh.*).

3. *The Skeleton.*

One of the most remarkable features of sponge structure is the skeleton. It is by far the most reliable basis for classifying the sponges yet discovered, inasmuch as it is comparatively unaffected by the external surroundings of the individual and

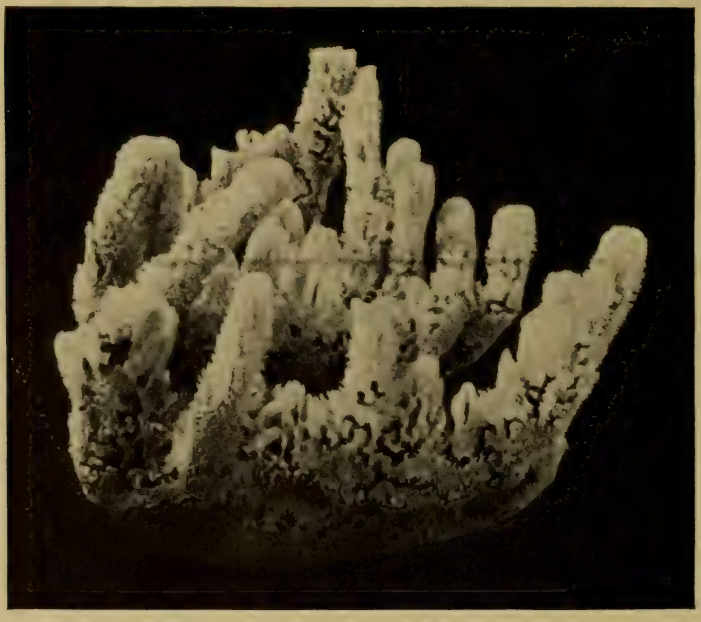


FIG. 12.—A BAHAMAN COMMERCIAL SPONGE (*Hippospongia sp.* Hyatt)
Showing colony of tube-like individuals

therefore its peculiar features remain constant to the groups of which they are characteristic. It may be composed either of fibers or spicules, and it is secreted by the mesoderm. Its function is to furnish a rigid supporting framework for the body and to act as a protection against the enemies of the sponge.

The fibrous sponges include among others those known to commerce. The skeleton is, in most cases, made up of interlacing and anastomosing fibers of a horny substance called *spongin*,

closely akin to silk in chemical composition. It is secreted by the mesoderm and is arranged so as to be a supporting basis to the layers of cellular tissue composing the soft parts of the animal. The fibers are of two kinds,—first, a set of long stout *principal fibers* (see Fig. 11), from $\frac{1}{2}$ to $\frac{1}{10}$ mm. in diameter, radiating from the base of the sponge to its surface, and secondly, a complicated network of fine *connective fibers* interlacing between the principal fibers and supported by them. The connective fibers are extremely delicate, having a diameter of only .01 to .02 mm. and with meshes scarcely as large as their diameter. Grains of sand are often found imbedded in the principal fibers, in some cases forming a considerable part of the skeleton, in others the entire substance. The spongin fiber is made up of a soft central core

FIG. 13—SOME TYPICAL FORMS OF SPONGE SPICULES

or *medullary axis*, surrounded with successive layers of the spongin substance. The classification of the horny sponges is based upon the minute characters of the network. A few sponges of small size have no skeleton at all, being supported by whatever rigidity their tissues may possess, but with these exceptions all except the horny sponges have skeletons made up of *spicules* instead of fibers. These are small needle-like bodies composed of either carbonate of lime or silicon. The latter is found combined with water in such proportions as to form a substance chemically resembling opal, and of transparent glassy appearance. Hence spicular sponges may be classified as calcareous or silicious according to the nature of their skeletons. Spicules may have one or two axes, or their axes may radiate in 3, 4, 5, 6, or even 8 different directions, and are found in a great variety of forms,

some of which are shown in Fig. 13. Those having one or two axes may be straight, curved, or bent at various angles. They may be pointed, rounded or knobbed at one or both ends. They may be smooth or spined. Spicules having a greater number of axes may also have their arms pointed, rounded or knobbed, or each arm may be branched, either once or twice, or to such a degree as to present a great variety of star-like figures. Spicules occasionally assume extremely odd shapes. Some look like tiny cuff-buttons, others like anchors, horseshoes and hooks of peculiar design, while still others are coiled like springs. As regards size they may be divided into two classes:

FIG. 14.—A DICTYONID SPONGE (*Farrea occa* Carter)
With rigid lattice-like skeleton.

megascleres, or large spicules, and *microscleres*, or small spicules. The megascleres form the main supporting structure of the skeleton and are bound together in long fiber-like bundles which are either parallel, or cross each other so as to form triangular or square meshes. They are sometimes entangled and interlaced in all directions like felt, clinging to each other with their hooks and projections. In the Dictyonid sponges (Fig. 14) the megascleres are of three axes at right angles to each other and are arranged with points overlapping During the life of the sponge these

grow together and finally form a perfectly rigid network. The microscleres on the other hand are not supporting in function. In fact in most cases their use is unknown. They are found embedded in the fleshy parts of the sponge and are so minute as to be distinctly visible only under a high power of the microscope. They are extremely valuable in determining species.

REPRODUCTION AND DEVELOPMENT.

Sponges may reproduce either by budding (*asexual reproduction*), or by means of eggs (*sexual reproduction*). Reproduction by budding is brought about by an outgrowth of cells from the side of the sponge involving all three layers. This finally develops

FIG. 15.—FRESH WATER SPONGES (*Spongilla* sp.)

into a miniature of the parent sponge, as far as structure is concerned, becomes narrowed at the base until it is only attached by a stem, and finally drops off. It then becomes fixed to the sea-bottom and grows to maturity. Sexual reproduction on the other hand is only effected by the union of sexual elements within the tissues of the parent sponge. The male and female reproductive cells originate in the mesoderm of the same individual and unite to form the fertilized unicellular egg. The larva is developed from the one-celled stage, by a process of cell division or cleavage. It passes through 2-, 4-, and 8-celled

stages by vertical divisions, at the end of which time it appears as a circular disc divided into eight equal segments. These again divide into a 32-celled stage by means of a horizontal or *equatorial* cleavage, and then, by repeated divisions of the eight upper cells, a hollow sphere is formed composed of eight large granular cells and many small cells, each of the latter bearing a long flagellum or whip-like filament. The eight large cells divide more slowly, always remaining comparatively large, and are not provided with flagella.

At this so-called *blastula* stage the larva issues from the

FIG. 16.—A GROUP OF NEPTUNE'S GOBLET SPONGES (*Poterion neptunei* Harting.)
The tallest specimen is 33 inches high.

endoderm of the parent and finally passes out through the osculum of the sponge. It swims rapidly about with its flagellate portion in front, and after a time the large granular cells grow around and enclose the flagellate cells. Soon a sup-chaped body is formed, known as the *gastrula*, which is covered with non-flagellate cells, and lined with a multitude of flagellate cells. The opening of the cup, or *blastopore*, now narrows and almost immediately the larva settles down and becomes fixed by the rim of the blastopore to a rock or some other object. The development is now very

rapid. The blastopore closes; the flagellate cells develop collars and become choanocytes; the osculum or excretory opening perforates the free end; the side walls are pierced with pores; traces of the skeletal spicules begin to show in scattered mesodermal cells as tiny needles of glass or carbonate of lime; and the body assumes a somewhat cylindrical shape. From now on the animal possesses all the elements of a true sponge, and growth proceeds according to its nature and environment.

PHYSIOLOGY.

This subject, in its application to sponges, is very imperfectly known.

The following facts, however, can be definitely stated:

The adult sponge is attached and is incapable of locomotion. Its only outward movements seem to be a slow dilatation and contraction of the pores and the osculum.

The choanocytes, however, are very active. The flagella are in constant vibration, and the collars are continually expanding and contracting. These cells are the chief organs of nutrition and respiration. The motion of the flagellum creates a whirlpool, by means of which the sea-water and the organisms it contains are sucked down within the collar. The cell then seizes upon, and absorbs the digestible organisms, while the constantly renewed sea-water, being brought into closer relation with the absorbing tissues, causes the necessary oxygenation to take place.

Excretory products are, without doubt, cast out by these cells and together with the indigestible organisms are borne out through the osculum by the main current of sea-water.

It is also said that during the winter many choanocytes disappear, to be restored in the spring-time. Thus a kind of hibernation seems to occur.

The growth of sponges is slow, five or six years being necessary to bring them to their full size. This, however, is very variable.

There is no muscular or nervous system. Instead, there is what has been called a "vague general sensibility" of the whole

sponge. This shows itself particularly in the movements of the osculum and pores.

Sponges may grow together if placed in contact, or, on the other hand, fragments cut from a sponge can be made to live and grow separately. This peculiarity is utilized in connection with the artificial propagation of the commercial sponges. Sponges do not, however, regenerate parts which have been cut off, although the original sponge may go on growing as if nothing had happened.

POSITION OF SPONGES IN THE ANIMAL KINGDOM.

The relation of sponges to other animal forms has always been very uncertain. The choanocytes of the endoderm seem to connect them with a group of colonial Protozoa known as *Choanoflagellates*. These are the only other animal forms which have "collared cells." In fact certain colonies of Choanoflagellates (*Proterospongia*) very much resemble primitive sponges. On the other hand sponges have often been grouped with the Cœlenterates, on account of the resemblance of the planula and gastrula larval stages to those of the Jellyfishes; because of the fixed condition of the adult, the simple structure and the sac-like internal cavity; as well as the supposed resemblance of the osculum to the Cœlenterate mouth. The latter resemblance is only apparent, however, as the osculum does not function as a mouth, nor does it have the same embryological history. Sponges, moreover, differ widely from Cœlenterates in their lack of tentacles and "sting-cells," or *nematocysts*, and are peculiar in having pores, "collared cells," and spicular skeletons. These differences are so important that it has been necessary to recognize the sponges as a separate subkingdom, most probably having a common ancestry in some group immediately derived from the Protozoa.

CLASSIFICATION.

On account of the difficulties besetting sponge classification many very widely differing schemes have been proposed. The earliest were based largely on external forms and the chemical

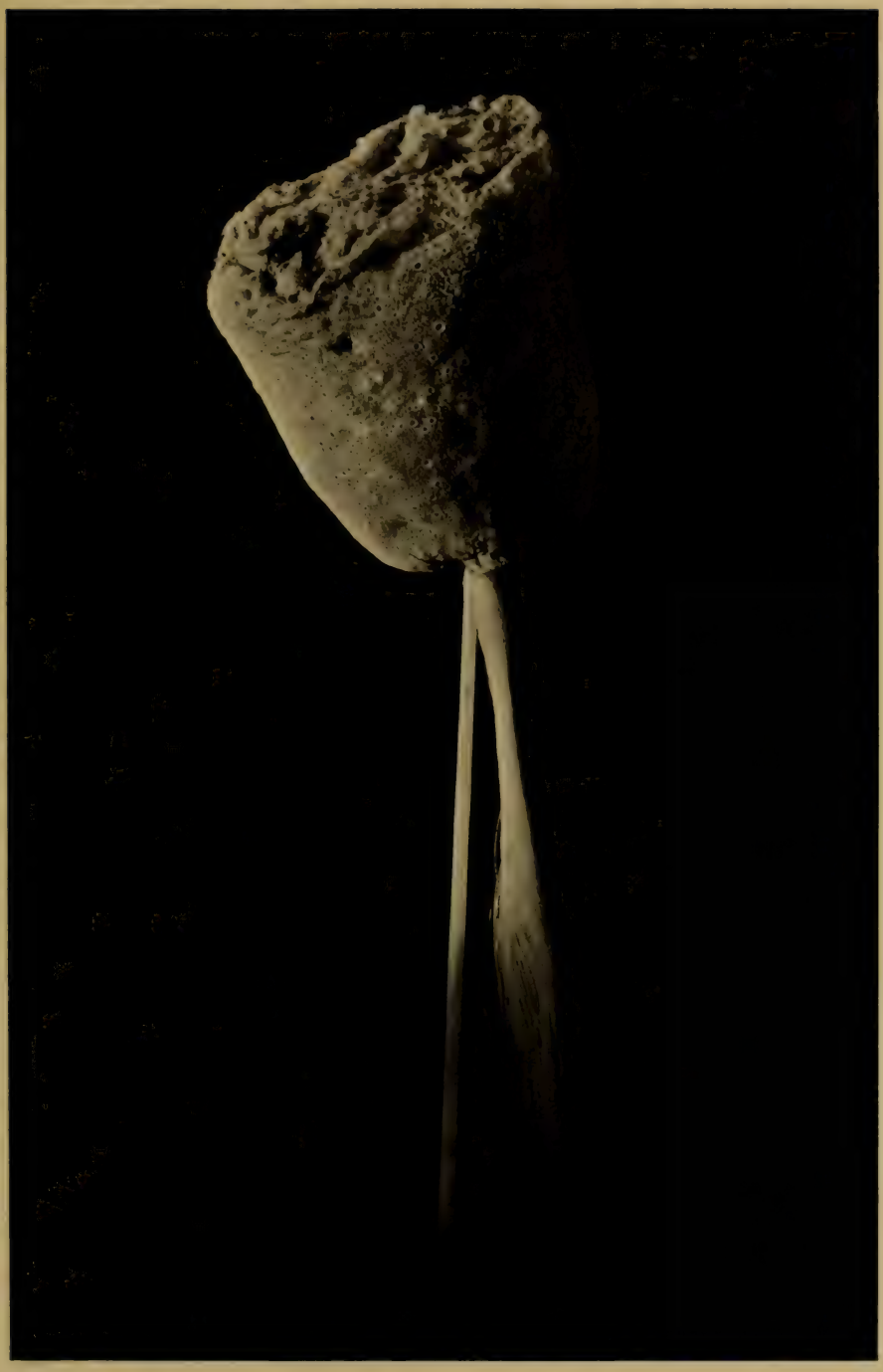


FIG. 17.—A GLASS ROPE SPONGE (*Hyalonema sieboldii* Gray)

The twisted rope-like bundle of opal spicules projecting from the base of the sponge, forms a supporting structure in life, the lower end being embedded in the mud.

composition of the sponge skeleton. The latter basis is still used for the division into classes, but the former has been for the most part abandoned on account of the plastic nature of the framework of sponges and the consequent variability of their growth-habits. Such internal features as the form and arrangement of the spicules, the extent of the choanocytic layers, and the general plan of the canal system, seem to be more constant characters, and are utilized in all recent classifications. There is, however, much variability among internal characters also, and there are yet many perplexing problems to the spongologist, especially on account of the great number of intermediate forms and unexpected relationships. In fact a genealogical diagram of the sponges would not so much resemble a branching tree, as a network with connecting fibers anastomosing in all directions, and most probably approximating in its appearance the bewildering skeletal labyrinth of the fibrous sponge itself. The following synoptic table, modified from Delage and Herouard, seems to be for the most part in harmony with recent researches, and as likely as any to have some degree of permanence, as it is largely based on internal structure, *i. e.* the skeleton and canal systems:

PORIFERA.

No nematocysts, no mouth, but with inhalent pores; a cloacal atrial cavity with a simple or multiple osculum; a mesoderm.

A. Class CALCAREA. Spicules calcareous; choanocytes large.

a. Order **HOMOCŒLIDA**. Atrial cavity lined with choanocytes. (*Leucosolenia*,* *Ascetta*, *Ascyssa*, *Homoderma*.)

b. Order **HETEROCŒLIDA.** Atrial cavity lined with pinacocytes (pavement cells), the choanocytes being withdrawn into radial diverticula or ciliated chambers. (*Sycon*, *Grantia*,* *Ute*, *Barroisia*, *Leucilla*, *Leucandra*, *Eilhardia*, *Eudea*, *Petrostoma*.)

B. Class NON-CALCAREA. Skeleton of silicious spicules, or of spongin fibers or no skeleton. Choanocytes small.

1. Subclass TRIAXONIÆ. Ciliated chambers large, elongated; skeleton of triaxial spicules or none.

a. Order **HEXACTINELLIDA.** Skeleton formed of spicules.

(1) Suborder LISSACINA. Spicules independent during growth. (*Euplectella*,* *Askonema*, *Rosella*, *Lophocalyx*, *Hyalonema*,* *Semperella*.*)

(2) Suborder DICTYONINA. Spicules united during growth to form a rigid trellis-work. (*Farrea*,* *Aphrocallistes*,* *Hexactinella*,* *Dactylocalyx*, *Ventriculites*, *Cœloptychium*.)

* Represented in Museum Collection.

b. Order **HEXACERATIDA.** Skeleton formed of fibers, or no skeleton. (*Darwinella, Aplysilla, Halisarca.*)

2. Subclass DEMOSPONGIÆ. Ciliated chambers small; skeleton formed of spicules of one or four axes; or no skeleton.

a. Order **TETRACTINELLIDA.** Skeleton formed of tetraxial megascleres, rarely reduced to microscleres, or no skeleton at all.

(1) Suborder CHORISTINA. Skeleton flexible, without interlocking desmas.

(i) Family **Sigmatophoridæ.** Megascleres present. Microscleres in the form of sigmaspires, or none. (*Tetilla, Cinachyra.*)

(ii) Family **Astrophoridæ.** Megascleres present. Microscleres in the form of asters. (*Thenea, Stelletta, Disyringa, Geodia, Pachymatisma.*)

(iii) Family **Microsclerophoridæ.** No microscleres. (*Plakina, Oscarella, Chondrosa.*)

(2) Suborder LITHISTINA. Skeleton rigid, formed of interlocking desmas

(i) Family **Triænidæ.** Ectosome containing triænes. (*Theonella, Desmanthus, Siphonia, Corallistes, Pleroma.*)

(ii) Family **Rhabdosidæ.** Ectosome containing microstrongyles, free or in desmas. (*Neopelta.*)

(iii) Family **Anoplidæ.** Ectosome without spicules. (*Azoriea, Vetulina.*)

b. Order **MONAXONIDA.** Skeleton formed of megascleres of only one axis.

(1) Suborder HADROMERINA. Ordinarily with a cortex; megascleres in radial bundles; microscleres in asters or absent, never in the form of spires or sigmas.

(i) Family **Aciculidæ.** Diactinous megascleres. (*Tethya, Hemiasterella, Stylocordyla.*)

(ii) Family **Clavulidæ.** Monactinous megascleres. (*Spirastrella, Suberites,* Polymastia, Cliona.*)

(2) Suborder HALICHONDRINA. Ordinarily no cortex; megascleres entirely oxeas arranged in a network. (*Spongilla*, Chalina*, Reniera, Halichondria, Tedania, Esperella, Cladorhiza, Myxilla, Clathria, Axinella.**)

c. Order **MONOCERATIDA.** Skeleton formed of spongin fibers with or without microscleres. (*Euspongia,* Hippospongia,* Aplysina,* Druinella, Stelospongia,* Hircinia * Spongelia,* Phoriospongia.**)

* Represented in Museum Collection.

TYPICAL SPONGES IN THE MUSEUM.

A. CALCAREOUS SPONGES (CLASS CALCAREA)

The most conspicuous characteristic of this class is the calcareous or carbonate of lime skeleton. The class is divided into two groups, the first containing those sponges whose hollow interior (paragastric cavity) is entirely lined with "collared cells" (order Homocœlida), the second comprising those in which the "collared cells" are confined to thimble-like prolongations of the paragastric cavity (order Heterocœlida).

An example of the **Homocœlida** is the Ascon sponge *Leucosolenia primordialis* Häckel. The genus to which this species belongs is found in all seas to a depth of 6000 feet. Its manner of growth varies from solitary, erect, cylindrical sponges to encrusting colonies of serpent-like tubes ramifying in a complicated network. Sometimes the whole colony assumes an erect vase-like form with walls made up of entwining tube-like individuals. The sponge on exhibition is of the encrusting type, growing in this instance on a colony of barnacles.

The Sycon sponge, *Grantia ciliata* Fleming, represents in the exhibition the order **Heterocœlida**. This is a common species found all along the New England sea-coast. It is a small tubular sac with the osculum surrounded by a circle of finger-like spicules, as shown in the illustration on page 224. It grows from an inch to an inch and a half in length, in small cluster-like colonies attached to sea-weed, submerged timbers, shells, etc. The specimens in the glass jar are growing on a mussel shell which is also partly encrusted with small star-shaped colonies of the interesting Ascidian, *Botryllus*.

B. THE NON-CALCAREOUS SPONGES (CLASS NON-CALCAREA).

The sponges of this class have no traces of carbonate of lime in their skeletons. Instead some contain silicious spicules

FIG. 18.—A RARE "GLASS" SPONGE (*Hyalascus similis* Ijima)
This graceful specimen illustrates the vase-like growth of many sponge colonies
(Height, 15 inches.)

(the so-called "glass" sponges), or their skeletons may be partly or entirely made up of a network of spongin fibers. A few sponges have no skeletons at all.

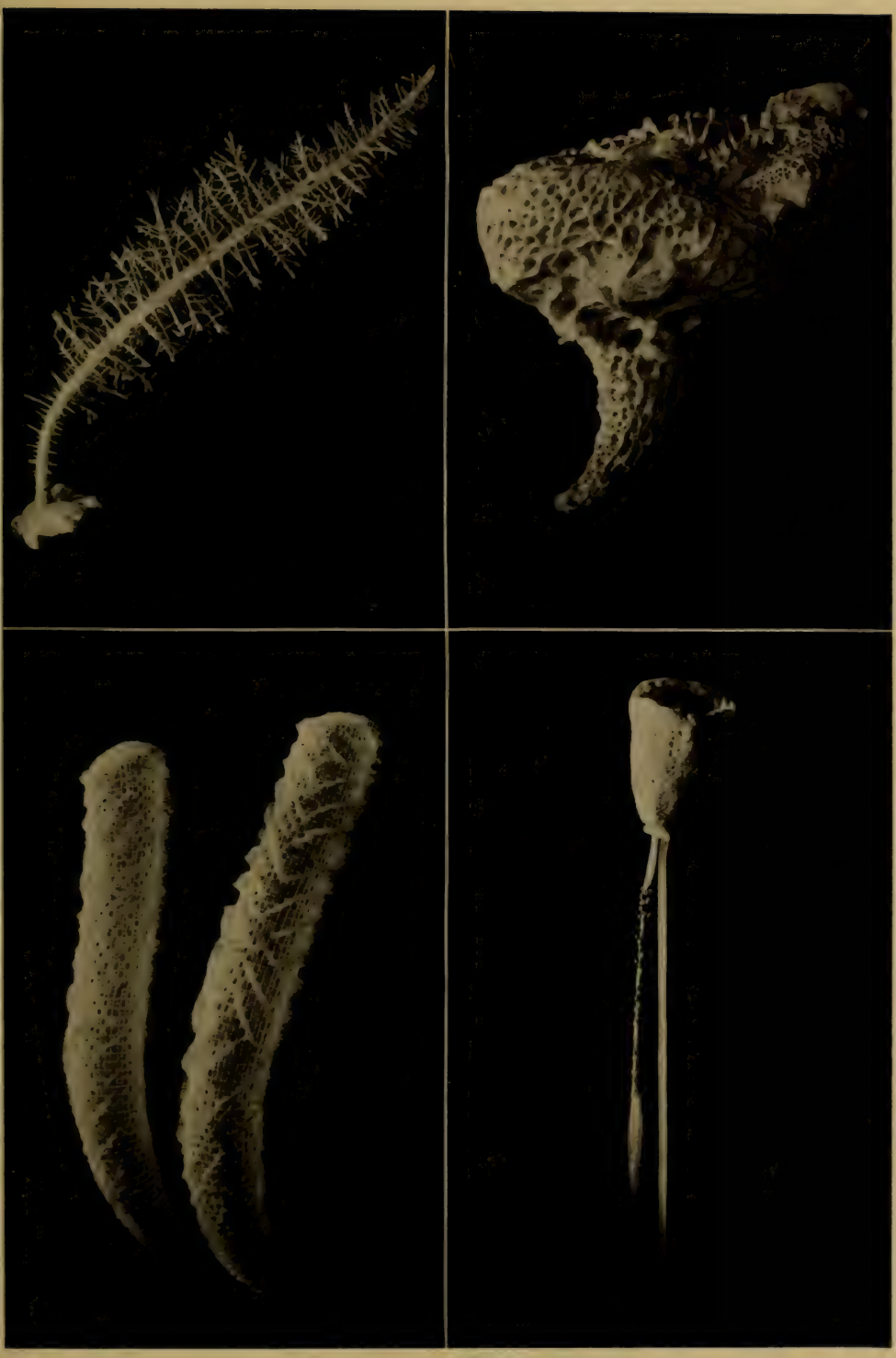
Those sponges which have six-rayed spicules belong to the order **Hexactinellida,** a group marked by forms of unusual beauty and grace, of which a fine collection is shown in this alcove. In some of these (suborder Lissacina), the spicules are independent during growth and are felted together by means of their hooks and spines; in others (suborder Dictyonina), the overlapping ends of the spicules have grown together to form a rigid lattice-like framework.

Suborder Lissacina.—The several species of *Euplectella* (Venus's Flower-basket) are especially noticeable for delicate beauty, while *Walteria* is remarkable for its odd tree-like form. *Acanthascus*, *Rhabdocalyptus* and *Crateromorpha* are also represented by fine specimens, (see opposite page) and give a good idea of the variety of forms which these sponges may assume, while the remarkable vase-like *Hyalascus similis* Ijima (Fig. 18, p. 239) is not only the type of its species, but is the only specimen known to have been found.

The so-called "glass-rope" sponges (*Hyalonema*) are remarkable for the twisted, cylindrical bundle of elongated spicules projecting from the lower end. In life this stalk-like support is anchored in the mud at the sea-bottom by means of barbs and hooks at the lower end of the spicules. An interesting peculiarity of this sponge is its association with tiny Zoöphytes (*Palythoa*) which are always found growing upon its stem (see Fig. 22). This is an illustration of the phenomenon of *symbiosis*, indicating an association of two animal forms for their mutual advantage.

Suborder Dictyonina.—The two specimens of *Farrea occa* Carter (see Fig. 14, p. 230) and *Aphrocallistes* show particularly well the lattice-like framework peculiar to this group, and also the characteristic manner of growth of these sponges.

The glass sponges are all universally distributed in the deep waters of tropical seas. Most of the specimens exhibited in this Museum were collected in the Sagami Sea, an arm of the Sea of Japan. This is a particularly favorable locality, as the sea-bottom falls away rapidly to a great depth close to the shore,



FIGS. 19-22.—SOME TYPICAL "GLASS" SPONGES

FIG. 19.—A tree-like species (*Walteria leuckhardti* Ijima).

FIG. 20.—The Cactus Sponge (*Acanthascus cactus* Schulze).

FIG. 21.—Venus's Flower-basket (*Euplectella speciosissima* Owen).

FIG. 22.—A "Glass-rope" Sponge (*Hyalonema owstoni* Ijima) with *Palythoa* growing on stem.

thus giving an opportunity for deep sea forms to stray up into comparatively shallow water.

The native method of collecting these sponges is interesting. An apparatus called a "dabo line" is used. This is a long line about an eighth of an inch in thickness, to which smaller branch lines or "snoods" are attached at short intervals. Each "snood" ends in a brass or iron wire hook with a barbed point. The "dabo lines" are coiled in baskets placed in the bottom of a boat manned by five or six men. The hooks are stuck in a row around the edge of the basket, and as the line is uncoiled, are successively unfastened by one of the men. The line is set by tying one end to the end of a long rope weighted with a stone sinker. The latter is then lowered perpendicularly, carrying the "dabo-line" with it, until the required depth is reached, when the upper end is moored to a buoy. The boat is then rowed away until the entire "dabo line" is paid out, when it is attached to another strong rope also weighted, which is lowered in the same manner as the first, and moored to a buoy. After a time the line is taken up, beginning at the first buoy, when sea-animals of all kinds including many "glass" sponges are found either hooked or entangled in the "snoods."

The order **Tetractinellida** comprises living and fossil forms, the skeletons of which are composed of four-rayed spicules.

The fossil Tetractinellids and other sponges are well shown in the Geological Hall, fourth floor, north wing of this building. *Hyalotrogos*, *Cnemidiastrum*, *Leidorella* and *Callopegma* are a few of the genera illustrated by the specimens.

The next great division of sponges, the order **Monaxonida,** comprises sponges having large spicules of but one axis. Sometimes these are arranged in radiating bundles and sometimes form a network. The species are quite numerous and universally distributed. The most remarkable of these sponges are the giant Neptune's Goblets (*Poterion neptunei* Harting), three fine specimens of which may be seen in a special case at the farther end of the alcove. At the left of these, another large cup-like Monaxonid sponge fished up near Santa Lucia, West Indies, may also be seen. This specimen (see opposite page) is remarkable for its size and beauty, for the peculiar irregular knob-like

FIG. 23.—A REMARKABLE VASE-LIKE MONAXONID SPONGE
From Santa Lucia, W. I. (Height 31½ inches).

projections on its surface, and for its very fragile texture. Other noteworthy specimens belonging to this order are as follows:

Spongilla sp. (illustrated on page 231.)—This is an example of the fresh-water sponges which form the only exception to the rule that sponges are marine animals. In color it is usually yellowish, often tinged with green or brown. It is universally distributed in streams and ponds.

Pachychalina.—This genus consists of usually elongate, finger-like and branching sponges in which the spicules are buried in a horny coating of spongin. The numerous excretory openings, or oscula, are conspicuously scattered over the external surface.

FIG. 24—THE STOLON-BEARING SPONGE (*Siphonochalina stolonifera* Whitfield)
A peculiar adaptation of the branching habit.

Siphonochalina.—This is closely related to the preceding genus, but consists of a group of tube-like individuals varying in form, and with spongin of somewhat paper-like texture. This genus is represented by several species, of which *Siphonochalina stolonifera* Whitfield is the most remarkable. This beautiful sponge is illustrated in the above cut of the type specimen. It consists of a number of tubes with crown-like summits, growing

FIG. 25.—THE TRUMPET SPONGE (*Tuba plicifera* Hyatt.)

from a common base, and connected with each other by root-like stolons, which form the attachments to the rocks on which they grow. The texture of the skeleton is very fine and smooth.

Tuba.—The genus *Tuba* is represented by two species *T. bullata* and *T. plicifera.* These are more or less trumpet-shaped as the name implies. The specimen illustrated on page 245 is especially fine.

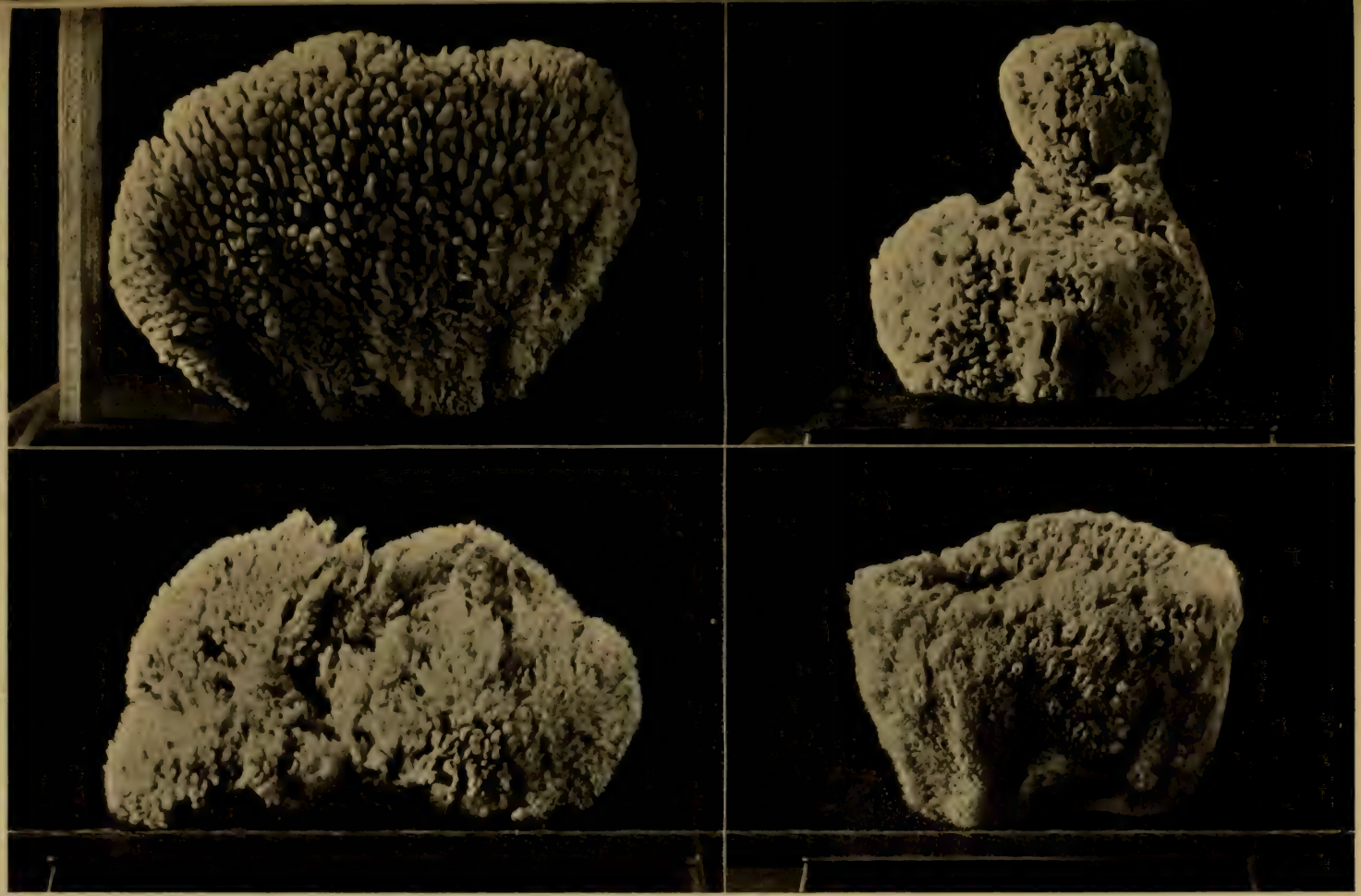
The Horny Sponges (order **Monoceratida**) includes the sponges whose skeletons are entirely made of the spongin substance. The most typical and most important of these are the commercial

FIG. 26.—THE ZIMOCCA SPONGE (*Euspongia zimocca* Schulze)

sponges. They are divided into the genera *Euspongia* and *Hippospongia.* In addition to these the fine finger-like sponges of the genus *Chalinopsilla*, the black branching skeleton of *Hircinia atra* Whitfield (type) and the graceful cup-like specimens of *Stelospongia* (see illustration on page 227) are worthy of note, although they possess no commercial value.

THE COMMERCIAL SPONGES.

The sponge of commerce is the elastic horny skeleton of spongin from which all the living tissues of the animal have been removed. The principal sources of supply are:



FIGS. 27-30—FOUR GRADES OF AMERICAN COMMERCIAL SPONGES.

FIG. 27.—The "Velvet" Sponge (*Hippospongia meandriformis* D. & M.).
FIG. 28.—The Florida Yellow Sponge (*Euspongia corlosia* D. & M.).
FIG. 29.—The "Sheep's Wool" Sponge (*Hippospongia gossypina* var. *hirsuta* Hyatt).
FIG. 30.—The Yellow Sponge (*Euspongia graminea* Hyatt).

(1) The Mediterranean coast, including the gulfs, bays and islands from Italy to the Levant, and the whole African shore.
(2) The Bahamas, Florida, and the north coast of Cuba.
(3) Australia and a few of the Pacific Islands.

There are three grades of European sponges, *i. e.*, the Turkey or Levant Sponge, the Horse Sponge, and the Zimocca Sponge.

FIG. 31.—THE SYRIAN SILK SPONGE (*Euspongia officinalis* var. *mediterranea* Schum.) The finest quality of Mediterranean sponge.

The Turkey or Levant Sponge (*Euspongia officinalis* var. *mediterranea* Schum.) is shown in the illustration. It is the finest grade of sponge known. Its texture is very soft, fine and silky. On account of the latter quality it is often called the Syrian Silk Sponge. This same species grows in Florida but is of very poor quality, probably on account of the climate and other differences in its surroundings.

The next grade of Mediterranean Sponge is the Horse Sponge (*Hippospongia equina* O. S.). Its quality is very fine and is paralleled on the Florida coast and in the Bahamas by the Velvet

and Sheep's-wool Sponges (*Hippospongia meandriformis* D. & M. and *H. gossypina* Hyatt). These are the best of American bath-sponges. (Figs. 27 and 29).

The third grade, the Zimocca Sponge (*Euspongia zimocca* F. E. Schulze), is not as soft as the others, and corresponds to the Florida Yellow Sponge or "Hardhead." (Figs. 26 and 28).

The Grass Sponge (*Euspongia graminea* Hyatt. Fig. 30) is the poorest grade of American sponge and is of little commercial value.

Sponges grow attached to rocks and other objects at the sea-bottom. They are obtained in shallow water by means of long iron hooks, which, however, often damage the sponges by tearing them. The most perfect specimens as well as the largest are obtained at greater depths by divers. The Dalmatian fishermen are very skilful at this. The diver is stripped and has a small rope attached to his waist weighted with a slab of stone. He seizes the stone in his hands and dives to the bottom. A skilful diver can remain under water for two to three minutes, during which time he quickly gathers whatever sponges he can find and places them in a net attached to his neck. He is then quickly drawn to the surface. Diving by this method is confined to the summer season, as the winters are too cold for such work. The Greek divers use a water-glass to locate their sponges. This is a metal cylinder somewhat longer than a band-box, open at the top and closed at the bottom by a plate of glass. By holding the glass-covered end below water, a person looking through it can easily see the bottom at a depth of 180 feet. The divers work in regulation diving-suits supplied with air from above. Under these circumstances they can remain below for a length of time varying from an hour to a few minutes, depending on the depth at which they are working. The best sponges are obtained in this way, as they are more perfect and of larger size in deep water, and can be removed from the rocks with greater care.

Dredging is also practised off the coast of Asia Minor.

Sponges are prepared for the market by first exposing them to the air until the animal matter begins to decay. They are then washed, either by beating, by treading them with the feet

or by exposing them to the action of the waves in so-called "crawls" or pens, until the skeletons are entirely freed of animal matter. They are then hung up to dry, baled, and sent to the market. Sometimes sponges are more quickly prepared by being bleached with chemicals. This gives them a very light color but impairs their quality. Sometimes when sold by weight they are adulterated with sand.

Sponge-fishing has been carried on so unwisely and with so little thought for the future, that the supply has been steadily declining in recent years, and lately the governments of the various countries concerned, foreseeing the almost certain destruction of the sponge industry, have attempted to regulate it in various ways and also to increase the supply by artificial propagation.

In Florida and Italy, more or less successful progress has been made, especially in the matter of sponge propagation. This is done in the winter season by choosing uninjured specimens and cutting them up into fine pieces about an inch square, on a board kept moist with sea-water. These "cuttings" are then placed on the ends of sharpened stakes held upright in a weighted wooden framework. This is sunk in a sheltered bay with a rocky bottom, free from mud, and protected from cold currents. If properly treated in this manner sponges will treble their size in a year and will be ready for the market in from five to six years.

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AMERICAN MUSEUM OF NATURAL HISTORY

Peruvian Mummies

By CHARLES W. MEAD

Department of Ethnology

GUIDE LEAFLET NO. 24

MARCH, 1907

2 CHULPAS, OR BURIAL TOWERS

Sillustani, Peru

Peruvian Mummies

AND WHAT THEY TEACH

A GUIDE TO EXHIBITS IN THE PERUVIAN HALL

By CHARLES W. MEAD

DEPARTMENT OF ETHNOLOGY

NO. 24

OF THE

GUIDE LEAFLET SERIES

OF THE

AMERICAN MUSEUM OF NATURAL HISTORY

EDMUND OTIS HOVEY, EDITOR

New York. Published by the Museum. March, 1907

PERUVIAN HALL NO. 302.

Gallery Floor, West Wing.

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	CASE
Mummy bundles	U 27
Mummies	U 27
Prayer sticks	R 4–5
Mummified animals	U 27
Trephined skulls	U 26
Skull Collection	U 26
Implements of war and the chase	U 21
Gold and silver objects	A
Baskets, mats and nets	R 17–18
Cloths	U 1
Materials and implements used in weaving	B
Quipus, or Record Fringes	R 1, 2
Coca leaves and outfit for chewing	R 11
Pottery	U 9, 10, 11, 12 and D, E, F
Chicha jars	On top of U 1, 3, 4, 5, 6, 7, 27
Collection from the West Indies	U 2
Musical Instruments	U 25

"U" refers to the upright cases; "R," to the railing cases.

PERUVIAN MUMMY BUNDLES AND MUMMY

PERUVIAN MUMMIES AND WHAT THEY TEACH.

By Charles W. Mead,

Department of Ethnology.

ANCIENT Peru, the land of the Incas, comprised not only the region included within the present Republic of Peru, but also the greater part of Ecuador, Bolivia and Chile and was about equal to that portion of the United States lying east of the Rocky Mountains. The Incas proper were a powerful tribe of warlike people inhabiting the great central plateau, from which dominating position they extended their conquest in all directions. They developed a much higher order of civilization than was found in other parts of the continent by the early European explorers, and the empire under their sway included many tribes speaking different dialects.

The history of the Ancient Peruvians must to a large degree be read in their graves, since they left no written records and the Spanish conqueror destroyed many of their cities and suppressed their customs. Like many other peoples the Peruvians bestowed much tender care on their dead, carefully preparing them for burial and placing with them in the ground many objects which were dear to them in life. Methods of burial are so intimately connected with the religious and other customs of a people that in the absence of other sources of information a study of graves or tombs may be expected to lead to important results. Fortunately for the archæologist, climatic conditions in some parts of Peru are such that "burials" have been well preserved. The region west of the Peruvian Cordillera, a narrow strip along the coast, is in the main a desert, the only fertile spots being the narrow valleys of the small rivers flowing down to the Pacific.[1] The tombs and graves are usually found on elevated places outside of the valleys where the extreme dryness of the air combines with the nitrous character of the sand, into which moisture has seldom found its way, to desiccate and preserve the bodies of the dead thus mummifying them naturally. The same factors have

Importance of the Burials

[1] The visitor is referred to the relief map of South America on the left as he enters the hall for a clear exposition of the topographic features of the region.

caused the clothing and objects placed with the dead to be preserved for many centuries.

As a rule the bodies were prepared for burial by placing them in a sitting position with the knees drawn up and the head and hands resting upon them, as is shown in the right-hand figure on page 6. Sometimes, however, as appears from burials in the Chira Valley, in the extreme northwest of Peru, the body was extended at full length. A few of the extended bodies have been found in other parts of the country, and two examples of this form from Surco, Peru, are in the collection. After the body was placed in position, it was enveloped in wrappings of various kinds. Sometimes the body was covered with fine cotton cloth, over which were placed finely woven blankets or ponchos of the wool of the vicuña or the alpaca, with designs in various colors.

Preparation for Burial

The body and its wrappings were bound together by a net-work of stout cord of vegetable fibre; by a piece of strong cloth sewed together in the form of a closed sack, or in some localities by a casing of woven rushes. The "mummy bundle" was surmounted by the so-called "false head," which was sewed to its upper surface. The significance of this practice is unknown. These false heads, many of which are present in the collection, were made of cloth and filled with different vegetable substances. The face was represented in various ways: sometimes by a mask of wood or clay, but often the eyes, nose and mouth were made of wood, shell, gold or silver and fastened directly to the cloth by means of thread. To the outside of the mummy bundle were often attached several of the prayer sticks or sepulchral tablets which are frequently found in considerable numbers in the sand about the grave. These are either in the form of a cross wound with variously colored yarns, or a framework of split reeds, covered with cloth upon which rude designs are painted. Favorite animals were sometimes buried with the dead as is shown by the mummified bodies of a dog and a parrot in the collection.

Mummy Bundles

The manner of interment of the mummy bundle and its accompaniments differed in various localities. In the coast region many of the mummies are found in little vaults, or "huacas," of adobes or flat stones roofed with sticks or canes, overlaid with mats or a layer of rushes, which prevented the earth covering from filling the grave. These vaults usually contain from one to four bodies.

Huacas

hydrous chloride of copper, which is much prized on account of its easy reduction. The age of the mummy is unknown, but it is supposed to be pre-Columbian.

Weapons and Implements

The story told by the objects found with the Peruvian dead is in part the story of ancient Peruvian life. The objects in the Peruvian collection in the hall, most of which have come from graves and mummy bundles, have been arranged so as to tell part of this story. For example we find with the bodies of men slings for throwing stones, stone-headed clubs and bolas (rounded stones joined by cords), showing the weapons and implements of war and the chase. With the mummy bundle of the woman have been found work-baskets, filled with threads and yarns of various colors, needles of thorn and copper, the implements used in weaving, such as spindles and shuttles, or the stones used in smoothing and polishing the outside of pottery vessels. Woman's work in ancient Peru is indicated by the presence or absence of objects familiar to us of the present day. Corn, beans and other foods were usually placed beside the body in the grave, together with vessels used in eating and drinking. These objects indicate not alone the belief of the people in a future world and the necessity of sustaining the spirit in its journey thereto, but they also show that the people were well advanced in agriculture, and we are enabled to determine the kinds of plants cultivated and in many cases even the methods by which they were prepared for use.

EAR OF CORN: FOUND WITH A MUMMY

Furthermore the objects found in the graves prove that in the working of copper, silver and gold the ancient Peruvians take high rank, and

CUP OF BEATEN GOLD AND STRING OF GOLD BEADS

show that the people knew how to exploit and treat the ores occurring in their land. Among copper implements there may be seen in the collection a great variety of spear points, club-heads, digging and planting implements, knives and axes. Tweezers are among the most familiar objects from the graves, and are often found suspended from the neck of a mummy by means of a cord.

Use of Copper

Some of the most notable of the gold objects are a cup beaten from a single piece, and ornamented in repoussé-work; human and animal figures, both solid and hollow, and beads and pins. The illustration on page 13 shows the gold cup and a string of large gold beads. In silver there are cups and vessels which, like the gold cup, are beaten from single pieces and are often ornamented with human or animal figures and other designs. Silver tweezers in many fanciful forms, pins and a variety of ornaments have been found in and with the mummy bundles. These objects prove that the makers were familiar with the processes of casting in moulds, beating and soldering. Many of the hollow figurines were made in three or more pieces and the parts soldered together.

Gold and Silver

Another remarkable class of objects is to be found on the right as one enters the hall. Here are many garments and pieces of cloth which were found wrapped around the dead or deposited in the graves. A glance at this part of the collection will show the ancient Peruvians had great skill in the art of weaving. Upon closer examination it will appear that they were familiar with most of the weaves known to modern people, from the finest gobelins to the coarsest cotton cloth. Many of the specimens cannot be excelled at the present time. The looms used were of the simplest description, consisting of two cross-sticks, one at the top, and the other at the bottom. The warp threads were stretched from one to the other, while the woof or filling was passed over and under these by a shuttle. So the weaving of these most perfect fabrics may be said to have been by hand. In this respect they may stand in contrast to the modern machine methods. In addition to the excellence of weave Peruvian cloth is unique in decoration. The designs are woven in and consist of geometric figures and conventionalized representations of men, pumas, jaguars and various kinds of birds and fish. Some of the forms are illustrated on page 16. A part of the decorative effect is due to the regular repetition of the same design in different colors.

Cloth and Weaving

That the Peruvian should also take high rank as a potter will be gathered from even a superficial study of the collection of all forms of pottery at the west end of the hall, since many of the vessels show real beauty of outline and form and excellence in their painted decoration. These qualities seem the more remarkable when we consider that the

PIECES OF CLOTH FOUND WITH MUMMIES

makers had no knowledge of the potter's wheel and were unacquainted with the art of glazing. Some of the vessels were shaped by hand, but others show that they were formed by means of moulds. The body was moulded in two parts which were joined by being pressed together. Spout or handle, if desired, was then attached, and all irregularities in the junctures remedied by scraping and rub-

Pottery

POTTERY WATER-JAR WITH CORN DECORATION

bing. Moulds were often used in making many of the animal heads and human figures that adorn these vessels. The decoration was put on with paint, and, after firing, the vessels were polished by rubbing with a smooth pebble.

In the absence of an aboriginal written language in Peru and on account of the meagreness of the descriptions left by the first Europeans who visited the country, it is fortunate for the student of Peruvian archæology that the potter often represented by the shape of his vessel or in its

POTTERY VESSEL WITH PAINTED DECORATION

decoration forms and customs which were familiar to him in his every-day life.

Representations of the human figure are common. Some of these show the manner of wearing the poncho and other articles of clothing. Some have in the lobe of the ear the large cylindrical ear-ornaments which led the Spaniards to nickname these people "Orejones" — big ears. It would be impracticable, however, to mention here more than a few of the subjects depicted. On one vessel a man pursues and kills a deer with a spear; on another a hunter is returning with the body of a deer thrown across his shoul-

Human figures

ders. Some jars show the manner of catching fish by means of hook and line, while others portray men and women carrying water jars and other burdens by means of a strap passing around the forehead. Here we see a man with his favorite bird, evidently of the parrot family, perched upon his shoulder; there a dance in progress, with several of the figures playing upon musical instruments.

These potters were very fond of moulding their clay into animal forms, and they have left us more or less truthful representations of many of the species familiar to them. Their favorite models appear to have been the puma, jaguar, monkey, llama, Guinea-pig, lizards, birds of the parrot family, the king vulture and a number of shells and vegetable forms. A complete list would include most of the animal and many of the vegetable forms of Peru.

Animal figures

Everywhere, except in the most elevated parts of the country, maize was not only the staple food of the people, but also was the source of their favorite intoxicating beverage,— *chicha*; hence it was but natural that they should so often represent the grain on their vessels. This was very simply and perfectly accomplished. A mould was made from an ear of corn and dried in the sun or fired. Into this clay was pressed; which on being removed would be a facsimile of the ear. This was joined to the jar while both were still in a plastic condition, after which the whole was fired and polished. A corn jar is represented in the illustration on page 17.

Chicha

Although this guide relates chiefly to burials, it may not be out of place to call attention to some peculiarities of Peruvian skulls. The skulls of all races are of great scientific value, but those of Peru are of particular interest, because many of them bear the marks of surgical or sacrificial operations. The Museum collection of Peruvian skulls is so extensive that only a representative series is on exhibition. This contains many examples showing trephining, artificial deformation and pathological conditions, together with several normal Peruvian skulls for purposes of comparison.

Trephined skulls

In Peru, where stones from slings and wooden clubs with heads of stone and copper were the common offensive weapons, complex fractures of the skull with depression of its bony plates must have been common. There seems no reason to doubt that trephining was resorted to as a means of relief in such fractures, and that sometimes cures were effected by this treatment. It is also probable that the operation in many

21

TREPHINED SKULLS FROM ANCIENT PERUVIAN GRAVES

cases was a part of some religious ceremonial, since some of the trephined skulls in the collection show distinct orientation of the wound and present no indication of lesion. Implements of copper and bronze and knives of stone and obsidian must have been employed in the operation, which was performed with skill.

Artificial deformation of the head was extensively practised in ancient Peru and was accomplished by means of ligatures applied in infancy. The form taken by the head was determined by the manner in which these bindings were applied. The pathological skulls show the ravages of disease in the bones of the cranium.

THE QUIPU.

The Quipu is a fringe consisting of a main cord with other cords of various colors hanging from it. In the fringe knots of different kinds were tied. The ancient Peruvians, having no written language, made use of the quipu to keep their accounts and possibly to record historic incidents. By the color of the cord, the kind of knot, the distance of the knots from the main cord and from each other, many facts could be recorded and preserved. The maker of a quipu had a system which was to a great extent arbitrary, and which had to be explained when the quipu was placed in the keeping of another.

COCA CHEWING.

The coca plant (*Erythroxylon coca*, Lam.) grows wild in the mountainous regions of Peru and Bolivia and was cultivated before the Conquest, as it is to-day, in districts from 2,000 to 5,000 feet above the sea. It is valued for its stimulating narcotic properties, and the present Indians will often carry heavy burdens for several days without food, if furnished with a plentiful supply of coca. The leaves are gathered and dried in the sun and then chewed mixed with unslacked lime in the same way the betel is used by the East Indians. A bag of coca leaves is almost always found with a mummy. The leaves of this plant, together with the cloth bags in which they were carried and the gourd flasks containing lime may be seen in the collection.

MISCELLANEOUS EXHIBITS.

This gallery contains many exhibits, some of them very important, of which no special mention has been made, since it is believed that the case labels and the guide leaflets attached to the cases will furnish the desired information to the student and visitor. Among these may be mentioned the collection from the West Indies, the musical instruments of the Incas, the case containing a great variety of animal forms in pottery; collections of feather-work from Peru, Bolivia, Paraguay and Brazil, and the collection from Columbia consisting of many objects in pottery, stone and shell.

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#25

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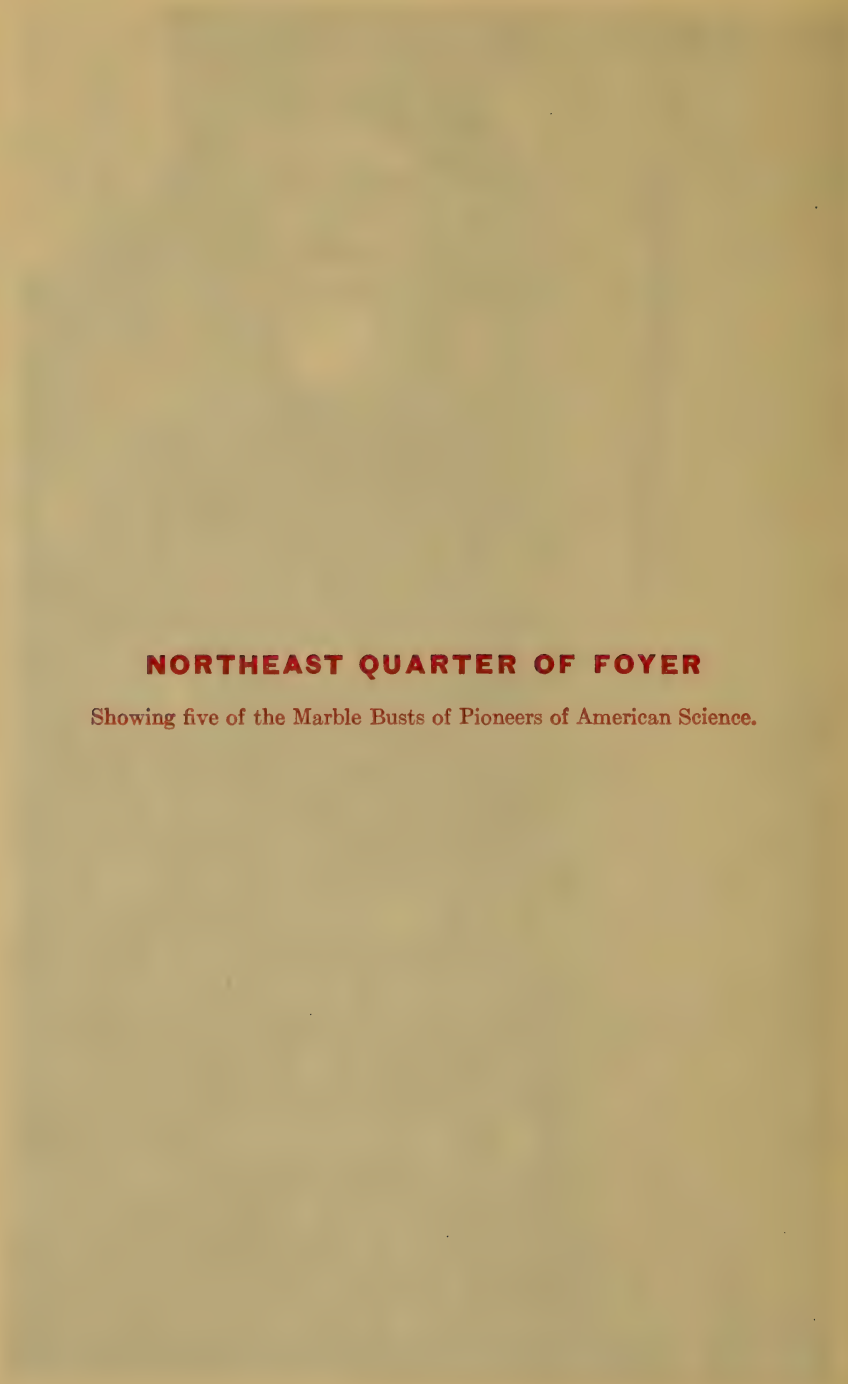

NORTHEAST QUARTER OF FOYER

Showing five of the Marble Busts of Pioneers of American Science.

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AN ACCOUNT OF THE EXERCISES HELD

AND THE ADDRESSES DELIVERED

AT THE

AMERICAN MUSEUM OF NATURAL HISTORY

DECEMBER 29, 1906

PIONEERS OF AMERICAN SCIENCE.

Saturday, December 29, 1906, was notable in the annals of the Museum, since at 3 o'clock of that day there were held in the large auditorium the ceremonies attending the unveiling of the marble busts which have been installed in the foyer, representing ten of the men who have been foremost in the advancement of science in America. The auditorium was crowded to its full capacity with Members of the Museum and their friends and visiting scientists, and Professor H. F. Osborn, Second Vice-President of the Museum, presided in the absence, due to illness, of Mr. J. Pierpont Morgan, First Vice-President. The exercises began with the singing of the national anthem "America," after which Dr. Hermon C. Bumpus, Director of the Museum, acting for Mr. Morris K. Jesup, addressed the Trustees as follows:

"Thirty-six years ago several men of this city organized to perform three closely-related functions:

1, To establish and maintain a museum of natural history;

2, To encourage and develop the study of the natural sciences;

3, To advance the general knowledge of kindred subjects.

"Of this company, Mr. Morgan was one; a second (Mr. Choate) is he who will receive on behalf of the Honorable Board of Trustees the splendid gift that has brought this congregation of scientists together, and a third is he who for more than twenty-five years, as President, has devoted his time, his thought, his energy, his influence, his means, his health, not for the mere naked fulfilment of the terms of the Articles of Incorporation, but for the up-building of an institution that would excite civic pride, for the molding of forces that would result in educational power, for the combination of material that would develop character and for the general exploration of the secrets of Nature, be they hidden in the remote regions of Siberia, in the unknown land and waters of the North, in the ancient monuments of the South or the outcropping foundations of the continent in the West.

"To what extent the sympathetic union of these three men with other earnest workers in a common cause has been successful in the establishment and maintenance of a museum of natural history, none are better able to judge than the members of the various scientific and educational organizations,— the guests that honor the Museum by their presence

this afternoon. Many of our guests today are frequent students of the Museum's collections, frequent readers of the Museum's publications and frequent users of the Museum's library.

"But it is the effort to fulfill the terms of the second paragraph of the Articles of Incorporation — the paragraph that refers to the encouragement and development of the Study of the Natural Sciences, that provides for the aggressive invasion of the unknown and for the encouragement of those who enter the unknown for search and research — it is the effort to fulfill these terms that has characterized the administration of this institution and made it something different from a mere museum.

"The prime incentive for the pursuit of science is doubtless indiscoverably hidden among those forces that direct the growth and activities of the human body, but the strongest secondary incentive is appreciation — commendation. An institution that is pledged to the encouragement and development of the natural sciences ought certainly to appreciate and commend those who have conspicuously devoted themselves to the pursuit of science. It is in response to this feeling of obligation and with the hope that such recognition at this time might act as a helpful incentive to those attending the important scientific meetings now being held in New York, that these exercises have been arranged.

"In an adjoining hall, as we leave this auditorium, we shall find unveiled ten portraits of the pioneers of American science, the work of one of America's leading sculptors, Mr. William Couper.

"It is this series of busts that I have the honor, on behalf of Mr. Morris K. Jesup, to present to the Trustees for permanent exhibition in this Museum, and with it may I convey the desire that they may serve as a token of the donor's esteem for all who have devoted and are devoting themselves to the development of science, and also that all entering this institution may feel that the study of the natural sciences is encouraged and developed, not by immediate results alone, but also in the proper recognition of those who have unselfishly labored for its advancement."

In accepting the gift, Hon. Joseph H. Choate said in behalf of the Board of Trustees:

"As you have already heard, it is only in my accidental capacity of survivor that I have the honor of appearing here today to receive this gift. Mr. Morgan could not come, Mr. Jesup could not accept

his own gift, — he knows how much better and more delightful it is to give than to receive, — and so I stand here for a moment on behalf of my fellow trustees, to receive this splendid donation.

"If this were Mr. Jesup's only gift to the Museum, it ought to place him among the immortals. To place in our vestibule, at the entrance of these halls of science, the busts of these great pioneers and masters, to place them here so that the future generations of New York and of America may become familiar with their features would be in itself a very great and valuable gift. Ever since the foundation of this Museum thirty-seven years ago, he has been enriching and endowing it with wonderful gifts.

"Most of you are perfectly familiar with the chief of these, — the Jesup Collection of Woods, containing the wood of every tree known to be existing in North America, a perfectly unique collection which cannot anywhere be repeated; the collections that were brought by the Jesup North Pacific Expedition from the shores of British Columbia, Alaska and Asia are also unique in their way; and in the Hall of Vertebrate Palæontology a large portion of that wonderful exhibit is from his generous hands. Even now, today, he is fitting out for our benefit an expedition for the exploration of fossils in northern Egypt, and I am sure that when Professor Osborn, who is to head the expedition, returns next spring, he will come 'bearing his sheaves with him,' in the form of the fossil remains of the ancestral elephant, which he will find somewhere between the mouth of the Nile and the Nubian Desert — exactly where I cannot tell, but he, at this moment, with his prophetic vision could put his finger upon the very spot.

"This Museum, if you will notice the date, was born in the Dark Ages of the City of New York — in 1869 — when the public enemy was in possession of the city and of its treasury. It was a gloomy day for the foundation of such an institution. I believe it was about that time that one board of public officials, catching a strange ray of light for that dark time, had employed the celebrated Dr. Hawkins to prepare models of the vast fossil mammals for exhibition to the people. They gave him a house in Central Park, where he set to work on that great study. By and by, there came in another set of public officials who were as antediluvian as the fossils themselves, and they broke his models all up and sent the doctor on his way not rejoicing at all.

"We never dared in those days to hope or expect help from the

City for such an institution as this, but light soon dawned upon us, and gradually year by year the City Officials and the people of the City began to find that this was a great educational institution maintained for the benefit of the people. But it was hard struggling in those early days. Despair followed anxiety, and our Trustees knew not which way to turn. But when Mr. Jesup, twenty-six years ago, took the presidency of this body, he found that certain fossils still lingered in the Board of Trustees, and actually breathed into us the breath of life. He has kept us alive ever since, and every year this Museum has exhibited new energy and success, and more than three fourths of it is due to his generous gifts and his inspiring presence.

"He has given us something far better and grander than material assistance, liberal as he has been with that. He has given us twenty-six of the best years of his life, devoted with untiring generosity to the success of this enterprise. It is also to be remembered to the great credit of Mr. Jesup that it was during his administration that the Museun took one significant step forward, which we had long been hesitating to do — I mean the opening of the Museum to the public on Sundays. It was the best advance we ever made. We found that we could do our duty to the church in the morning and come here with equally reverent minds in the afternoon to study these collections and look through Nature up to Nature's God, and the people found that out too.

"And so with grateful hearts the Trustees accept this last and noble offering, and I am sure you will all with one voice join with me in saying — God bless the noble donor."

After Mr. Choate's address brief memorials of the men of science whose portraits have been selected for the foyer, were delivered in accordance with the following program:

BENJAMIN FRANKLIN, by Dr. S. Weir Mitchell of Philadelphia;

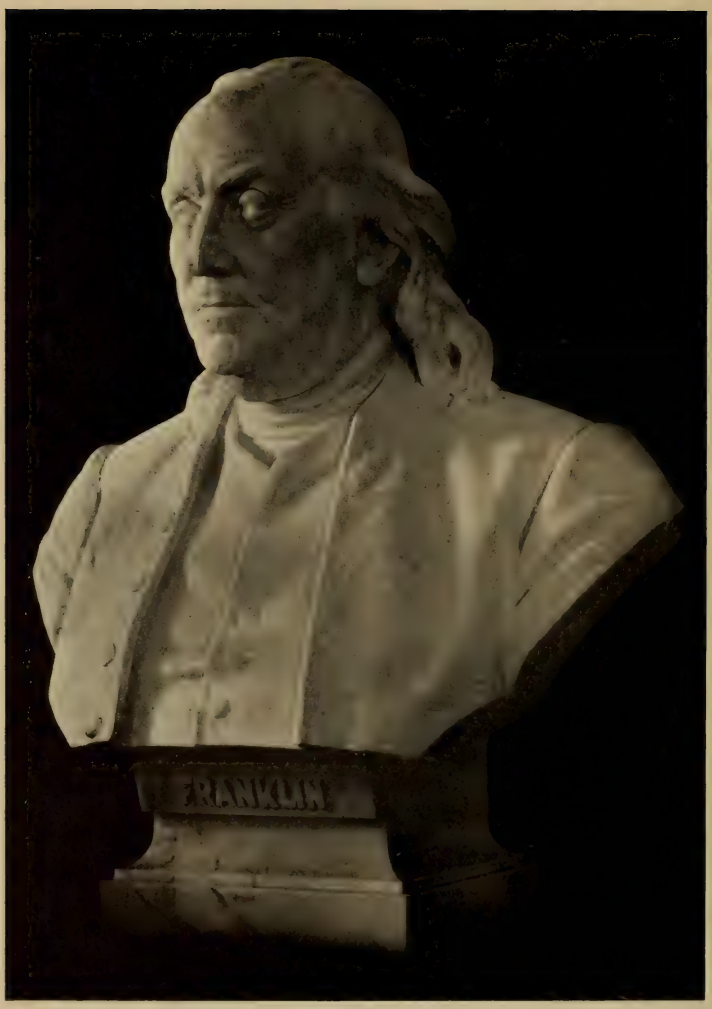
ALEXANDER VON HUMBOLDT, by His Excellency, Baron Speck von Sternburg, German Ambassador. (Read by Major T. von Körner, Military Attaché of the Embassy);

JOHN JAMES AUDUBON, by Dr. C. Hart Merriam, Chief, U. S. Biological Survey, Washington, D. C.;

JOHN TORREY, by Dr. Nathaniel L. Britton, Director in chief, New York Botanical Garden, New York City;

JOSEPH HENRY, by Dr. Robert S. Woodward, President, Carnegie Institution, Washington, D. C.;

LOUIS AGASSIZ. Letters were read from the Rev. Edward Everett Hale, an


FRANKLIN

BENJAMIN FRANKLIN

Born, Boston, January 17, 1706.
Died, Philadelphia, April 17, 1790.

Physicist, author, editor, philosopher

Demonstrated the identity of lightning and electricity

intimate personal friend of Professor Agassiz, and Professor F. W. Putnam, of Harvard University, and remarks were made by Professor Addisson E. Verrill of Yale University and Dr. C. D. Walcott, Director of the U. S. Geological Survey;

James Dwight Dana, by Dr. Arthur Twining Hadley, President, Yale University, New Haven, Conn.;

Spencer Fullerton Baird, by Dr. Hugh M. Smith, Deputy Commissioner, Bureau of Fisheries, Washington, D. C.;

Joseph Leidy, by Professor William Keith Brooks, Johns Hopkins University, Baltimore, Md.;

Edward Drinker Cope, by Dr. Henry Fairfield Osborn, Curator, Department of Vertebrate Palæontology, American Museum of Natural History.

The addresses as delivered were as follows:

BENJAMIN FRANKLIN.

By S. Weir Mitchell.

We are here, as I understand, to unveil memorial busts of Americans distinguished in science, and I am honored by the privilege of speaking of Benjamin Franklin. This man, the father of American Science, was possessed of mental gifts unequalled in his day. Even yet he holds the highest place in the intellectual peerage of a land, where, in his time, men had few interests which were not material or political. But no man entirely escapes the despotic influences of his period. Thus in every life there are unfulfilled possibilities, and so it was that, paraphrasing Goldsmith, we may say that Franklin to country gave up what was meant for mankind, when with deep regret he resigned in middle life all hope of whole-souled devotion to science. When most productive, his scientific fertility was the more remarkable because of the other forms of dutiful activity which, in a life that knew no rest, left small leisure for those hours of quiet thought without which science is unfruitful of result.

There is a Hall of Fame not built by the hand of man. It is the memory of mankind. In many of its galleries this man's bust could with justice be placed. Diplomacy would claim him as of her greatest. For him would be the laurel of administrative wisdom. Among statesmen he would be welcomed. Who of the masters of English prose shall in that hall of fame be more secure of grateful remembrance, and who more certain of a place among men of science?

As an investigator of Nature and of Nature's laws he is materially represented here by right of eminent achievement. Let us as men of science feel proud that Franklin's fame as a philosopher did much to win for Franklin the diplomatist such useful consideration and respect as led to final success.

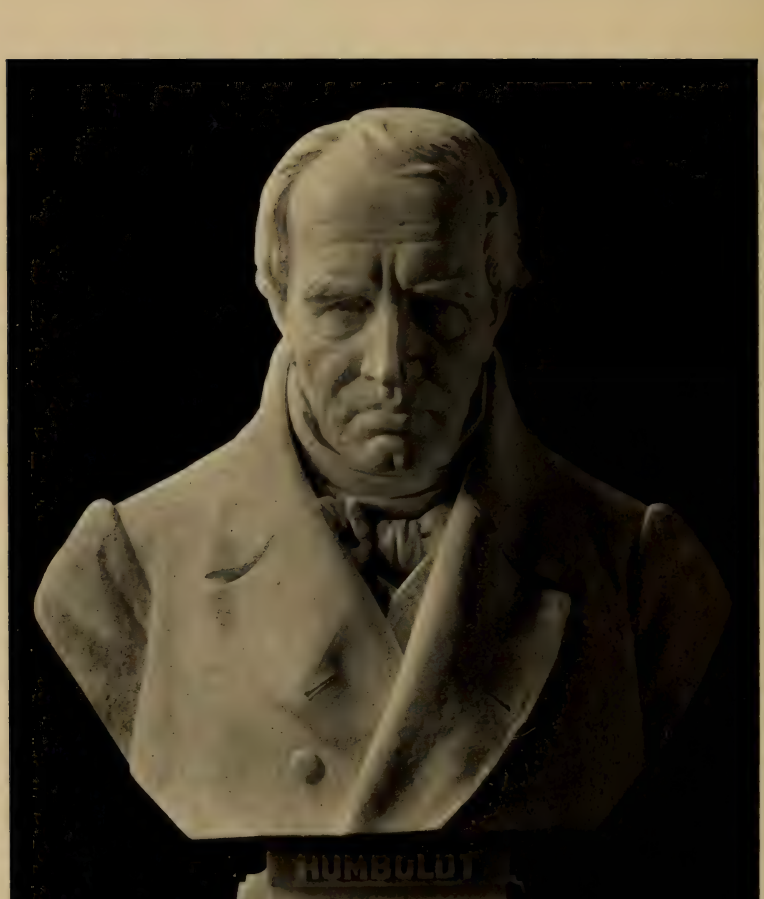
Many of those you honor today had moral and temperamental peculiarities which more or less influenced their lives and are common to men of science. Most of them cared little about making money; still less about keeping it. Franklin on the contrary dreaded poverty; was careful in business, made fruitful investments and died rich; nevertheless like the typical man of science he refused to make money out of his discoveries, or to protect his inventions by patents. In him the man of science, unselfish, free from money greed, seemed to exist apart from all those other men who went to the making of the many-minded Franklin. In another way he was singularly unlike such typical men of science as Henry, in physics, and Leidy, in natural history. When Franklin made a discovery, his next thought was as to what practical use it could be put. If he made some novel observation of nature, he asked himself at once how he could make it serve his fellow men. The great reapers of the harvest of truth commonly leave the inventor to make practical use of their unregarded thought.

Leaving the wide land to do justice to Franklin, the model citizen and great diplomatist, here we crown with the assured verdict of posterity Franklin, the man of pure science. Here we welcome him to this goodly fellowship of those who communed with Nature and read the secrets of the Almighty Maker.

ALEXANDER VON HUMBOLDT.

Mr. President, Gentlemen:

His Excellency, the German Ambassador, whom heavy official duties retain at Washington, has requested me to represent him on this occasion and to express to you his hearty congratulations on this event on which through Mr. Jesup's generous munificence this commemorative tribute is paid to the world's great masters of science, a day on which this magnificent museum of natural history has received a donation which will awake a solemn sense of reverence and make this abode


HUMBOLDT

ALEXANDER VON HUMBOLDT

Born, Berlin, September 14, 1769
Died, Berlin, May 6, 1859

Geographer, traveler, philosopher

Described the surface features and the geological structure of many lands

henceforth a temple of devotion to the founders and promoters of natural science.

Whoever honors the memory of great men, honors science and honors himself, and so the Ambassador has asked me to convey to the generous donor, the tireless promoter of science, Mr. Jesup, the expression of his sincerest admiration and of his heartfelt thanks for the honor which will be conferred also upon the great German scholar, Alexander von Humboldt.

In this immortal man, whose bust you have gathered to unveil, the world reveres its greatest master since the days of Aristotle. His genius covered all that man has ever thought, done and observed in nature. There is no branch of human knowledge into which his mind did not penetrate. His "Cosmos," that marvellous monument of meditation and research, is a new book of Genesis in which the Universe mirrors itself in all its vastness and minuteness "from the nebulæ of the stars" — to use his own words — "to the geographical distribution of mosses on granite rocks."

By his wonderful talent of research, by his almost superhuman power to divine eternal laws, this great interpreter of science taught mankind how to read the book of nature, how to understand its great mysteries. The series of sciences, originated by this mighty genius is, as well as the other manifold branches of science developed by him, sufficiently known to all.

In all his investigations his ultimate aim was to bring theory into practical relation with life. Thus he not only elevated the standard of culture of the whole world by many steps, but he also became from a practical point of view the benefactor of mankind in many branches of common life,— as trade, commerce, navigation.

He taught us how to conceive the beauty and sublimity of nature in its every form and motion. His studies are not a matter merely of memory and of dry meditation, to him Nature was rather the inexhaustible source of pure and deep enjoyment, by which the heart is purified and ennobled and men are brought nearer to perfection.

It is not necessary to give you a more detailed picture of his life. All this is so well known and so dear to the whole learned world of America; for never has a foreign scholar been more honored in this country than Alexander von Humboldt. To realize this we need only recall the celebrations which took place in his memory throughout all

America both at the time of his death and on the occasion of the centennial anniversary of his birth.

Humboldt devoted five years of his life to scientific investigations in South and Central America, in Mexico and in Cuba. He ascertained the course of the greatest rivers; he climbed the summits of mountains where man's foot had never trod before; he studied vegetation, astronomical and meteorological phenomena, gathered specimens of all natural products and a great deal of historical information about the early population of these parts of the New World. It was he that drew the first accurate maps of these regions. With almost prophetic forecast of the needs of generations to come, he examined the Isthmus of Panama and considered carefully the possibility of establishing there an interoceanic waterway.

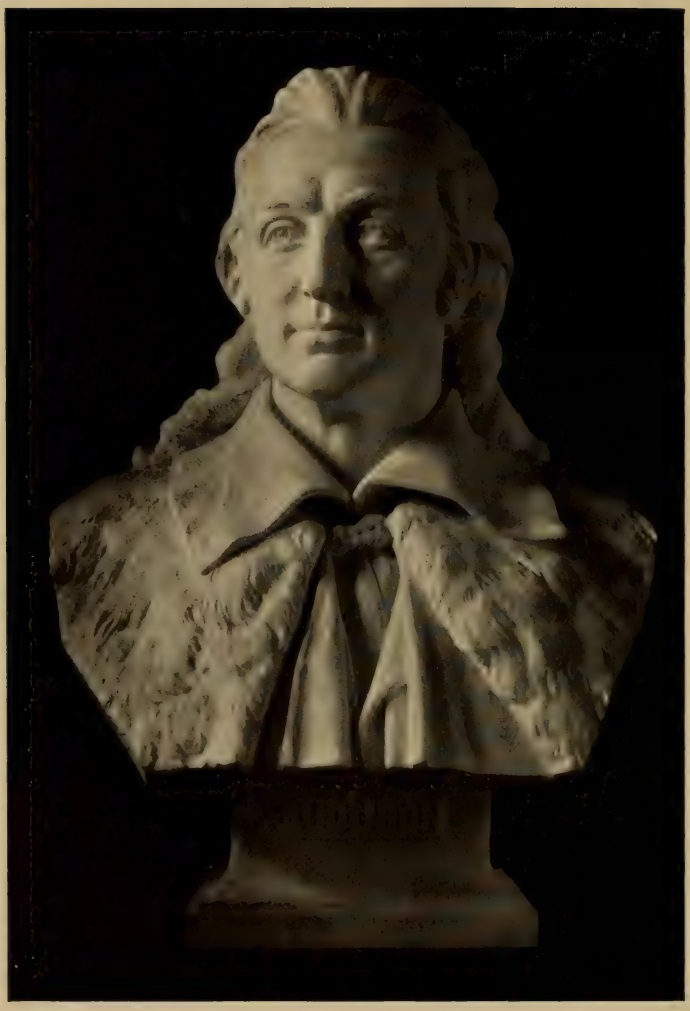
It is well known how great an interest Alexander von Humboldt took in the United States. Indeed, so strongly was he attracted by the problems of the new-born Republic that putting aside even his habitual scientific occupations, he devoted himself entirely for some months to the study of the American people and the institutions of this country.

Finally, the great scientist, he whom people call the scientific discoverer of America, returned to his country, carrying with him a vast store of intellectual and material treasures of science. So abundant were the results, reaped from his expeditions, that he needed the coöperation of the best scholars of his time to compile that great mass of material, and to place it in proper shape and form.

Throughout his long and industrious life, Alexander von Humboldt ever retained his love for and devotion to the country where his great field of labor lay, and for its people with whom he always felt closely connected by his love for freedom in thought and for liberty. It is a well-known fact that in his later days of all the foreigners, who knocked at his door, no one was more heartily welcomed than the American citizen.

The benefits of his investigations in America returned to that country in the course of time. No wonder that her people recognize him as their benefactor. Another great man, whose monument will be unveiled today, and most deservedly placed beside the one of Alexander von Humboldt, Louis Agassiz, says of him:

"To what degree we Americans are indebted to von Humboldt, no



JOHN JAMES AUDUBON

Born, New Orleans, May 4, 1780
Died, New York, January 27, 1851

Ornithologist, artist

Chief work, "The Birds of America," illustrated with 1065 life-size colored plates

one knows who is not familiar with the history of learning and education in this country. All the fundamental facts of popular education in physical science beyond the merest elementary instruction, we owe to him." At another place he says, "Let us rejoice together that Humboldt's name will permanently be connected with education and learning in this country, for the prospects and institutions of which he felt so deep and so affectionate a sympathy."

Of all the tributes that have been paid to Alexander von Humboldt the most lasting and most fitting has now found its expression in this building. For here, in this magnificent American Museum of Natural History the ideal aim of all his theories is realized most perfectly: to cultivate the love of Nature, and thus to ennoble man and beautify his life.

Gentlemen, permit me to thank you for the honor you have done me today, and to express the hope that this splendid building may become a shrine of pilgrimage of scientists and students also of the Old World, helping to bind the nations closer together.

Baron Speck von Sternburg,
represented by Major Theodore Körner.

JOHN JAMES AUDUBON.

By C. Hart Merriam.

Of the naturalists of America no one stands out in more picturesque relief than Audubon, and no name is dearer than his to the hearts of the American people. Born at an opportune time, Audubon undertook and accomplished one of the most gigantic tasks that has ever fallen to the lot of one man to perform. Although for years diverted from the path Nature intended him to follow, and tortured by half-hearted attempts at a commercial life, against which his restive spirit rebelled, he finally broke away from bondage and devoted the remainder of his days to the grand work that has made his memory immortal.

His principal contributions to Science are his magnificent series

of illustrated volumes on the Birds [1] and Quadrupeds [2] of North America, his Synopsis of Birds,[3] and the Journals [4] of his expeditions to Labrador and to the Missouri and Yellowstone Rivers.

The preparation and publication of his elephant folio atlases of life-size colored plates of birds, begun in 1827 and completed in 1838, with the accompanying volumes of text (the "Ornithological Biography," 1831-1839), was a colossal task. But no sooner was it accomplished than an equally sumptuous work on the mammals was undertaken, and, with the assistance of Bachman, likewise carried to a successful termination. For more than three-quarters of a century the splendid paintings which adorn these works, and which for spirit and vigor are still unsurpassed, have been the admiration of the world.

In addition to his more pretentious works, Audubon wrote a number of minor articles and papers and left a series of "Journals," since published by his grand-daughter, Miss Maria R. Audubon. The Journals are full to overflowing with observations of value to the naturalist and, along with the entertaining "Episodes," throw a flood of light on contemporary customs and events. Incidentally, they are by no means to be lost sight of by the historian.

In searching for material for his books Audubon traveled thousands of miles afoot in various parts of the eastern states, from Maine to Louisiana; he also visited Texas, Florida and Canada; crossed the ocean several times, and conducted expeditions to far-away Labrador and the then remote Missouri and Yellowstone Rivers. When we remember the limited facilities for travel in his day, the scarcity of railroads, steamboats and other conveniences, we are better prepared to appreciate the zeal, determination and energy necessary to accomplish his self-imposed task.

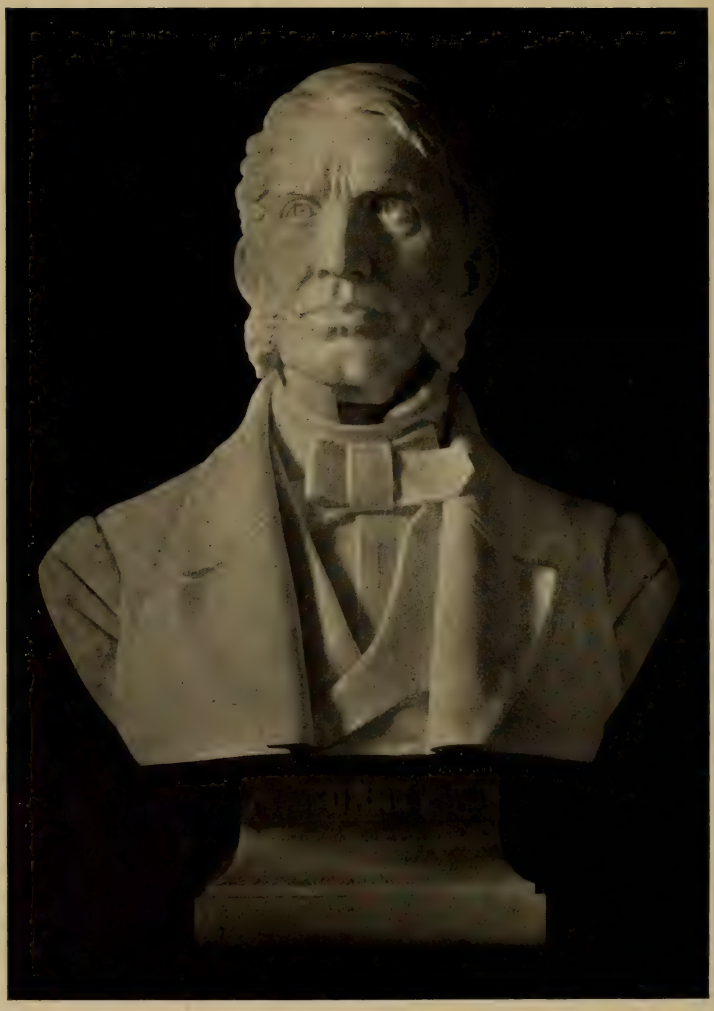
That it was possible for one man to do so much excellent field work, to write so many meritorious volumes and to paint such a multitude

[1] *The Birds of America,* 4 atlases, double elephant folio colored plates. London, 1827–1838; Ornithological Biography, an account of the habits of the birds of the United States. 5 vols. Royal 8vo, Edinburgh, 1831–1839.

[2] *The Quadrupeds of North America* by John James Audubon and Rev. John Bachman. 3 vols. Royal 8vo text, and elephant folio atlas of colored plates. New York, 1846–1854.

[3] *Synopsis of Birds of North America.* Edinburgh & London, 1839.

[4] *Audubon and his Journals* by Maria R. Audubon. 2 vols. 8vo. New York, 1897.



JOHN TORREY

Born, New York, August 15, 1796
Died, New York, March 10, 1873

Botanist, chemist

One of the founders of botanical science in the United States

of remarkable pictures must be attributed in no small part to his rare physical strength, for do not intellectual and physical vigor usually go hand-in-hand and beget power of achievement? Audubon was noted for these qualities. As a worker he was rapid, absorbed and ardent; he began at daylight and labored continuously till night, averaging fourteen hours a day, allowing, it is said, only four hours for sleep.

In American ornithology, in which he holds so illustrious a place, it was not his privilege to be in the strict sense a pioneer, for before him were Vieillot, Wilson and Bonaparte; and contemporaneous with him were Richardson, Nuttall, Maximilian Prince of Wied and a score of lesser and younger lights some of whom were destined to shine in the near future.

Audubon was no closet naturalist — the technicalities of the profession he left to others — but as a field naturalist he was at his best and had few equals. He was a born woodsman, a lover of wild nature in the fullest sense, a keen observer and an accurate recorder. In addition he possessed the rare gift of instilling into his writings the freshness of nature and the vivacity and enthusiasm of his own personality.

His influence was not confined to devotees of the natural sciences, for in his writings and paintings, and in his personal contact with men of affairs both in this country and abroad, he exhaled the freshness, the vigor, the spirit of freedom and progress of America, and who shall attempt to measure the value of this influence to our young republic?

Audubon's preëminence is due not alone to his skill as a painter of birds and mammals, or to the magnitude of his contributions to science, but also to the charm and genius of his personality, a personality that profoundly impressed his contemporaries, and which, by means of his biographies and journals, it is still our privilege to enjoy. His was a type now rarely met, combining the grace and culture of the Frenchman with the candor, patience and earnestness of purpose of the American. There was about him a certain poetic picturesqueness and a rare charm of manner that drew people to him and enlisted them in his work. His friend, Dr. Bachman of Charleston, tells us that it was considered a privilege to give to Audubon what no one else could buy. His personal qualities and characteristics appear in some of his minor papers, notably the essays entitled "Episodes." These serve to reveal, perhaps better than his more formal writings, the keenness of his insight, the kindness of his heart, the poetry of his nature, the power of his imagination and the vigor and versatility of his intellect.

JOHN TORREY.

By Nathaniel L. Britton.

As a pioneer of American botany, John Torrey naturally finds a place among the men whose works we gladly celebrate today in this grand institution developed in the city where he was born; where he resided the greater part of his life, and where he died. Today's recognition of Torrey as a master of botanical science, is therefore peculiarly appropriate in New York, where he is already commemorated by the society which bears his name; by the professorship in Columbia University named in his honor, and by his botanical collections and library deposited by Columbia University at the New York Botanical Garden.

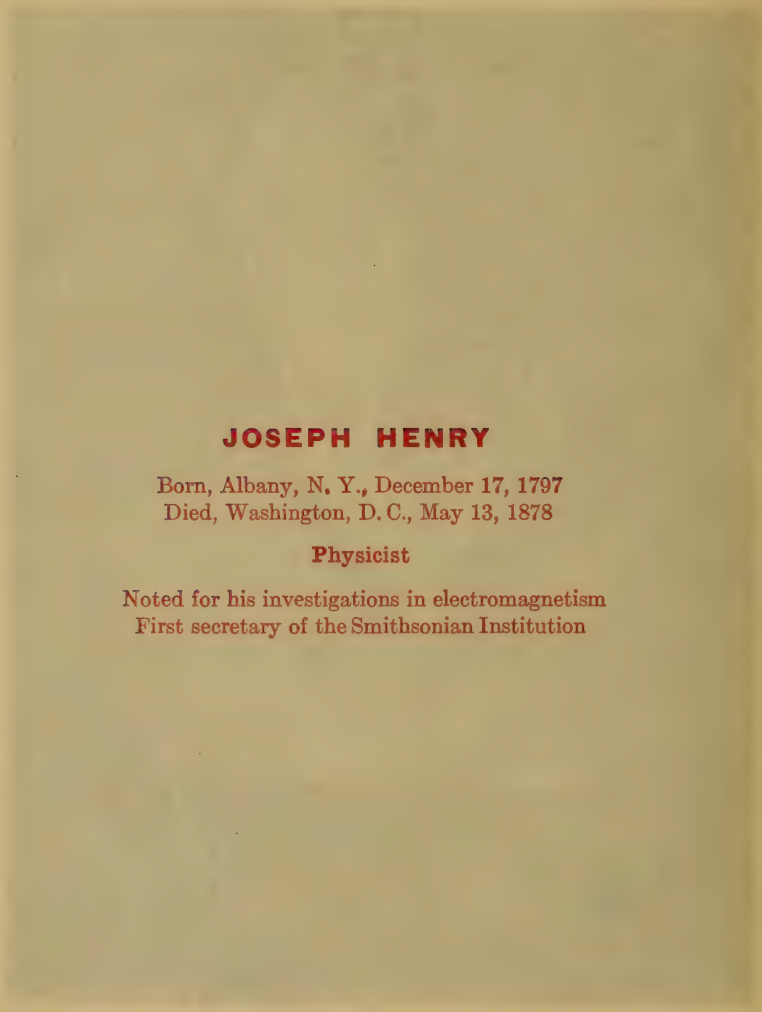
Dr. Torrey was born August 15, 1796, and died March 10, 1873, nearly thirty-four years ago; the pleasure of his personal acquaintance is therefore known to but few persons now living. We have abundant evidence, however, that he was honored and beloved to a degree experienced by but few; righteousness was instinctive in him; aid to others was his pleasure; he was tolerant and progressive, and his genial presence was a delight to his associates.

He was educated for the profession of medicine, graduating from the College of Physicians and Surgeons in 1818, but he soon abandoned it and in 1824 became professor of chemistry at West Point; after three years service there, he was elected professor of chemistry and botany in the College of Physicians and Surgeons, a position which he held for nearly thirty years, during part of this period lecturing on chemistry also at Princeton: he was also United States assayer in New York from 1854 until his death.

Dr. Torrey's attention was directed to botany during his youthful association with Professor Amos Eaton, and his interest in that science was subsequently stimulated during his medical studies by the lectures of Professor David Hosack. It early became his favorite study, and, notwithstanding his noteworthy services to chemistry, his fame rests on his botanical researches, although they were accomplished during his hours of rest and recreation, — largely during the night.

His botanical publications began in 1819 with "A Catalogue of Plants Growing Spontaneously within Thirty Miles of the City of New York," published by the Lyceum of Natural History, now the New York Acad-

HENRY



JOSEPH HENRY

Born, Albany, N. Y., December 17, 1797
Died, Washington, D. C., May 13, 1878

Physicist

Noted for his investigations in electromagnetism
First secretary of the Smithsonian Institution

emy of Sciences, and were completed the year after his death in the "Phanerogamia of Pacific North America," in Vol. 17 of the Report of the United States Exploring Expedition. His contributions to botany include more than forty titles, many of them volumes requiring years of patient study; they throw a flood of light on the plants of North America, and form a grand contribution to knowledge. His collections, on which these researches are based, were annotated and arranged by him with scrupulous care and exactness, and are treasured as among the most important of all scientific material in America.

JOSEPH HENRY.

By Robert S. Woodward.

This time, one hundred years ago, Joseph Henry, whose name and fame we honor today, was a lad seven years of age. He was born at Albany, New York, of Scotch parentage, his grand parents on both sides having come from Scotland in the same ship to the Colony of New York, in 1775.

Doubtless he had himself in mind when in his mature years he affirmed that "The future character of a child, and that of a man also, is in most cases formed probably before the age of seven years." At any rate, he found himself early, for at the age of sixteen he had determined to devote his life to the acquisition of knowledge. Thus he became, in turn, student; teacher; civil engineer in the service of his native State; professor of mathematics and natural philosophy in the Albany Academy; professor of natural philosophy in the College of New Jersey — now Princeton University — and a pioneer investigator and discoverer of the first order before he was thirty-three years of age.

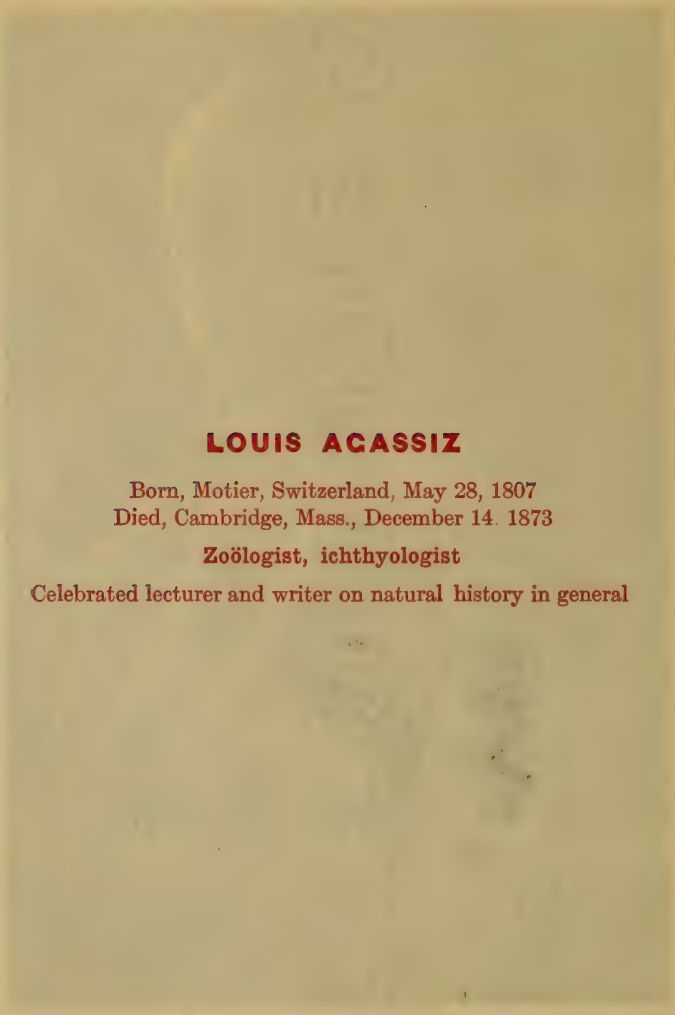
His inventions and discoveries in electromagnetism especially are of prime importance. They include the inventions of the electromagnetic telegraph and the electromagnetic engine and the discovery of many of the recondite facts and principles of electromagnetic science.

From the age of thirty-three, when he took up the work of his professorship at Princeton, till the age of forty-seven, when he was called to the post of Secretary of the Smithsonian Institution, he pursued his original investigations with untiring zeal and with consummate experi-

mental skill and philosophic insight. It was during this period that Henry and Faraday laid the foundations for the recent wonderful developments of electromagnetic science. The breadth as well as the depth of Henry's learning is indicated by the fact that he found time during this busy period for excursions and for lectures in the fields of architecture, astronomy, chemistry, geology, meteorology, and mineralogy in addition to his lectures and researches in physics.

He was a man rich in experience and ripe in knowledge when, in 1846, he assumed the administrative duties implied by the bequest of James Smithson, "To found at Washington, under the name of the Smithsonian Institution an Establishment for the increase and diffusion of knowledge among men." Thenceforth, for thirty-two years, until his death in 1878, he devoted his life to the public service, not alone of our own country, but of the entire civilized world. In this work he manifested the same creative capacity that had distinguished his earlier career in the domain of natural philosophy. He became an organizer and a leader of men. To his wise foresight we owe not only the beneficent achievements of the Smithsonian Institution itself, but also, in large degree, the correspondingly beneficent achievements of the Naval Observatory, the Coast and Geodetic Survey, the Weather Bureau, the Geological Survey, the Bureau of Fisheries and the Bureau of American Ethnology; for to Henry, more than to any other man, must be attributed the rise and the growth in America of the present public appreciation of the scientific work carried on by governmental aid.

We may lament, with John Tyndall, that so brilliant an investigator and discoverer as Henry should have been sacrificed to become so able an administrator. And American devotees to mathematico-physical science may be pardoned for entertaining an elegiac regret that Henry as a pioneer in the fields of electromagnetism did not have the aid of a penetrating mathematical genius, as Faraday had his Maxwell. But posterity, just in its estimates towards all the world, will recognize in Henry, as we have recognized in our earlier hero, Benjamin Franklin, a many-sided man — a profound student of Nature; a teacher whose moral and intellectual presence pointed straight to the goal of truth; an inventor who dedicated his inventions immediately to the public good; a discoverer of the permanent laws which reign in the Sphinx-like realm of physical phenomena; an administrator and organizer of large enterprises which have yielded a rich fruitage for the enlighten-



LOUIS AGASSIZ

Born, Motier, Switzerland, May 28, 1807
Died, Cambridge, Mass., December 14. 1873

Zoölogist, ichthyologist

Celebrated lecturer and writer on natural history in general

ment and for the melioration of mankind; a leader of men devoted to the progress of science; a patriot, friend and counsellor of Abraham Lincoln in the darker days of the Republic — in short, an exemplar for his race, a man whose purity and nobility are here fitly symbolized in enduring marble for our instruction and guidance and for the instruction and the guidance of our successors in the centuries to come.

LOUIS AGASSIZ.

A Letter from Edward E. Hale.

Read by Addison E. Verrill, who added interesting personal reminiscences of Agassiz.

Washington, D. C., December 8, 1906.

I think that the first time when I ever saw Agassiz was at one of his own lectures early in his American life. This was a description of his ascent of the Jungfrau. I think it was wholly extempore, and, though he was new in his knowledge of English, it was idiomatic and thoroughly intelligible. At the end, as he described the last climb, hand and foot, by which, as it seems, men come to the little triangular plane, only three feet across, which makes the summit, he quickened our enthusiasm by describing the physical struggle by which he lifted himself so that he could stand on this little three-foot table. He said, "one by one we stood there, and looked down into Swisserland." He bowed and retired.

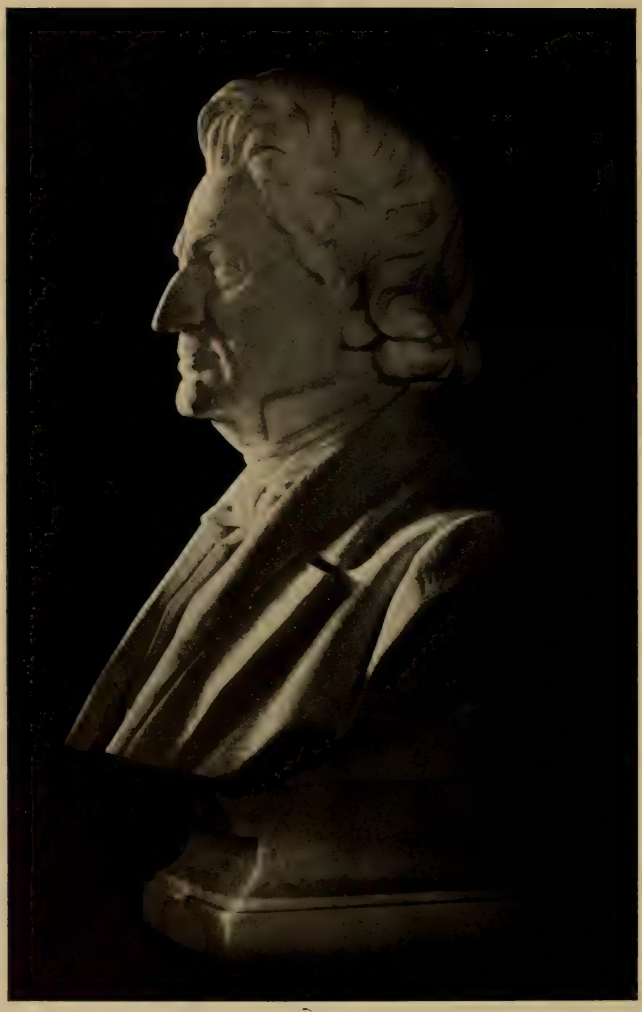
I know I said at once that Mr. Lowell, of our Lowell Institute, who had "imported Agassiz," (that is James Lowell's phrase) might have said before the audience left the hall, "You will see, ladies and gentlemen, that we are able to present to you the finest specimen yet discovered of the genus *homo* of the species *intelligens*."

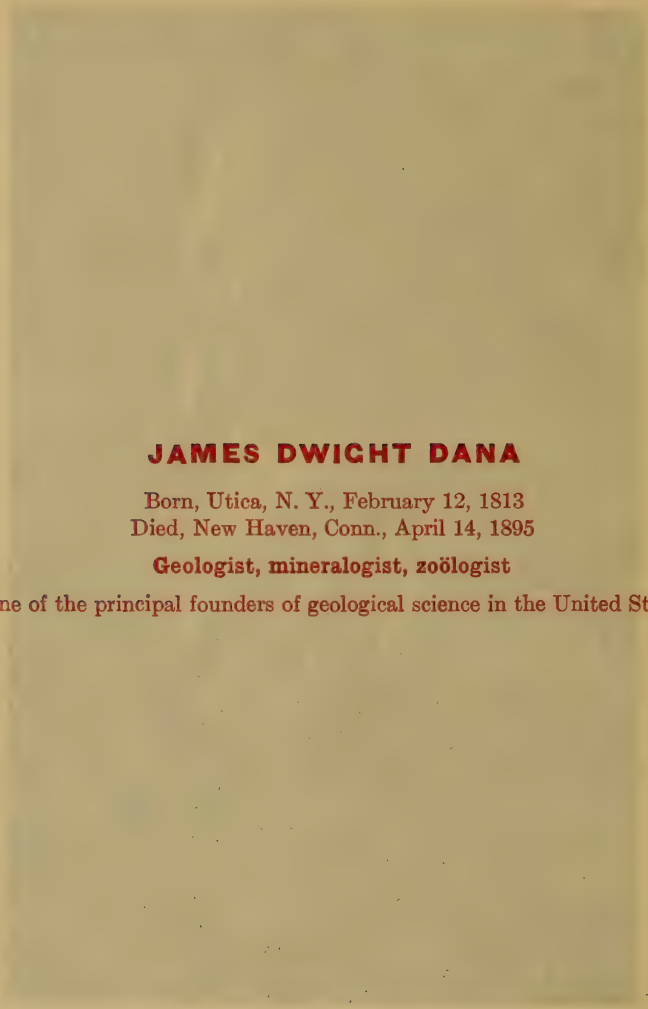
And looking back half a century, on those very first years of his life in America, I think it is fair to say that wherever he went he awakened that sort of personal enthusiasm. And he went everywhere. He was made a professor in Harvard College in 1848. But he never thought of confining himself to any conventional theory of a college professor's work. He was not in the least afraid of making science popular. He

flung himself into any and every enterprise by which he could quicken the life of the common schools, and in forty different ways he created a new class of men and women. Naturalists showed themselves on the right hand and on the left. I have seen him address an audience of five hundred people, not twenty of whom when they entered the hall thought they had anything to do with the study of Nature. And when after his address they left the hall, all of the five hundred were determined to keep their eyes open and to study Nature as she is. From that year 1848, you may trace a steady advance in Nature Study in the New England schools.

That is to say, that his distinction is that of an educator quite as much as it is that of a naturalist. In 1888, Lowell said, in his quatermillennial address at Harvard College, that the College had trained no great educator, "for we imported Agassiz." A great educator he truly was.

When Agassiz was appointed Professor he was forty-one years old. In my first personal conversation with him he told me a story which may not have got into print, of his own physical strength. He spoke as if it were then an old experience to him. Whether he were twenty-five or thirty-five when it happened, it shows how admirable was his training and his physical constitution. He had been with a party of friends somewhere in eastern Switzerland. They were travelling in their carriages; he was on foot. They parted with the understanding that they were to meet in the Tyrol, at the city of Innsbruck. Accordingly the next morning, Agassiz rose early and started through the mountains by this valley and that, as the compass might direct or his previous knowledge of the region. He did not mean to stop for study and they did not. But he had no special plan as to which hamlet or cottage should cover him at night. Before sundown he came in sight of a larger town than he expected to see, in the distance, and calling a mountaineer, he asked him what that place was. The man said it was Innsbruck. Agassiz said that that could not be so. The man replied with a jeer that he had lived there twenty years, and had always been told that that was the name of the place, but he supposed Agassiz knew better than he did. Accordingly Agassiz determined that he would sleep there and did so. The distance was somewhere near seventy miles. I know it gave me the impression of a walk through the valley passes at the rate of four miles an hour, for sixteen or seventeen hours.





JAMES DWIGHT DANA

Born, Utica, N. Y., February 12, 1813
Died, New Haven, Conn., April 14, 1895

Geologist, mineralogist, zoölogist

One of the principal founders of geological science in the United States

In later life Agassiz made to us some prophecies in which we may trace his enjoyment of the finest physical health and strength. Health and strength indeed belonged to everything which he said and did.

Among other things he said, twenty-five years ago, that the last years of our century, — the twentieth, would see a population of a hundred million of people in the valleys of the upper Amazon. I like to keep in memory this brave prophecy, because I am sure it will come true.

From a Letter from Professor F. W. Putnam.

Read by Charles D. Walcott, who gave also his own token of appreciation of Agassiz.

"It is a real grief to me that I cannot take this opportunity to offer tribute to my beloved and honored teacher, — Louis Agassiz. What a pleasure it would be to me to say a few words of appreciation of that great and good man. Not alone to speak of his scientific achievements, which are known the world over, but, from my intimate association with the great naturalist, to tell of all he did, fifty years ago, for the advancement and encouragement of the study of natural history; to picture his inspiring method of teaching; and to dwell on his goodness of heart, his genial magnetic personality and his wonderful power of winning the life-long devotion of his students."

JAMES DWIGHT DANA.

By Arthur T. Hadley.

It was my privilege to know James Dwight Dana intimately during my early years. To boyhood's imagination his figure typified the man of science; his life personified the spirit of scientific discovery. Wider acquaintance with the world has not in any way dimmed the brightness of that early impression.

The services of the geologist are today recognized by every one, and sought by all who can afford them. If he would make a voyage of exploration and discovery, the resources of the world of finance are

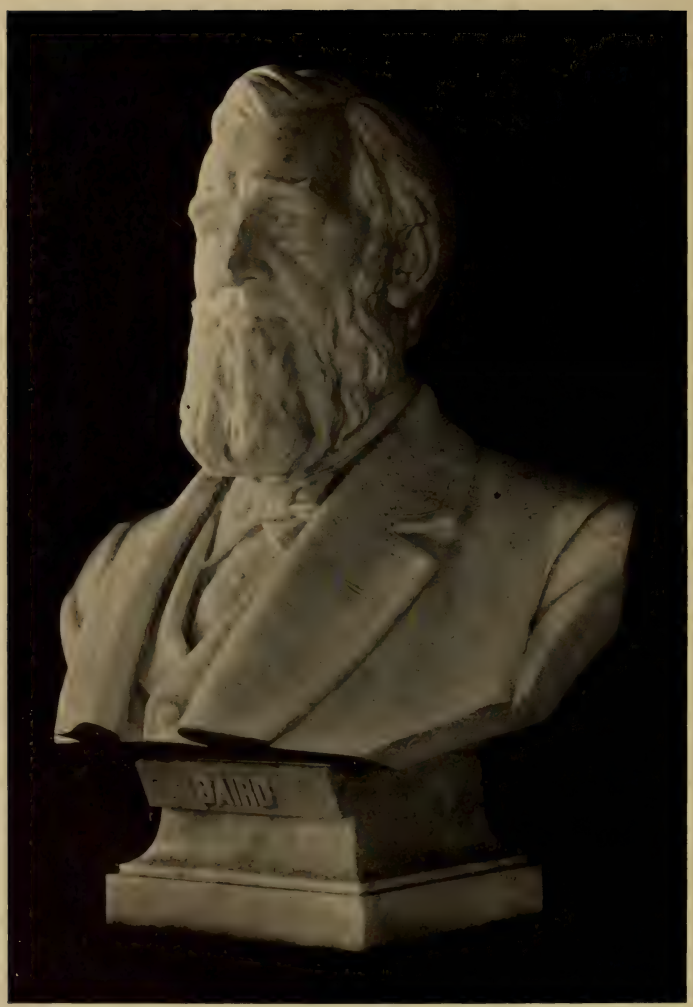
placed at his disposal. No such aids were given two generations ago. In Dana's journeyings he had to surmount hardship and peril, and to meet the coldness of those who knew not the value of the quest which he pursued. He and his contemporaries were like the knights errant of chivalry, devoting their lives to an ideal. They were men of faith, who combined the spirit of the missionary and the inspiration of the poet with the clear vision of the observer.

The largeness of Dana's work was commensurate with the largeness of his inspiration. It fell to his lot not only to fill out many pages of the record of the building of the world, as written in the fossil life of America, but to show in important ways the methods by which that building was accomplished. His creative brain never rested content with mere description of facts. He had the more distinctively modern impulse to reconstruct the process by which those facts were brought to pass. From his observations of coral islands in the various stages of their growth he deduced a geologic principle of world-wide importance. It is this characteristic which makes the great modern German school of geologists headed by Suess look to Dana as their precursor, more than to any other man of his generation.

He was not content with the work of discovery alone. The teaching spirit was strong within him. The pioneers in science needed editors and expositors who should make their results known. In each of these capacities Dana's achievements were phenomenal. Of his work as an editor he has left the files of the American Journal of Science as a monument. Of his work as an expositor those who have heard his lectures and attended his class room exercises can speak with unbounded enthusiasm. He was one of the rare men who by presence and voice and manner could bring the truths and ideals of science home even to those pupils with whom scientific study could never be more than an incident in their lives.

But above all his works and above all his qualities stands the figure of Dana himself — more than an explorer, more than a discoverer, more than a teacher; his countenance, as it were, illuminated by a touch of the light of a new day for which the world was being prepared.

> "His life was gentle; and the elements
> So mixed in him that Nature might stand forth
> And say to all the world, 'This was a man.'"


BAIRD

SPENCER FULLERTON BAIRD

Born, Reading, Pa., February 3, 1823
Died, Woods Holl, Mass., August 19, 1887

Zoölogist

Noted for his work in the Smithsonian Institution and the United States Fish Commission

SPENCER FULLERTON BAIRD.

By Hugh M. Smith.

The life, the character, the work of Spencer Fullerton Baird entitle him to recognition in any assemblage and on any occasion where honor is paid to those who have been their country's benefactors through illustrious achievements in science.

Developing a taste for scientific pursuits at a very early age, and confirmed in those pursuits through the influence of friendships with Agassiz, Audubon, Dana and other leading scientists of the time, Baird was selected as assistant secretary of the Smithsonian Institution when only twenty-seven years old, and there entered on a career devoted to the promotion, diffusion and application of scientific knowledge among men, and marked by dignity, sound judgment, fidelity to duty, versatility and general usefulness.

In the many phases of his intellectual development he resembled Franklin and Cope; in the multiplicity of his public duties and in the diversity of the scientific accomplishments in which he attained eminence he had few equals; in founding, organizing and simultaneously directing a number of great national scientific enterprises he was unique among those whose memory is here extolled today.

To render an adequate account of the branches of scientific endeavor in which he achieved prominence, benefited his own and future generations and added to his country's renown, one would need to be an ornithologist, a mammalogist, an ichthyologist, a herpetologist, an invertebrate zoölogist, an anthropologist, a botanist, a geologist, a palæontologist, a deep-sea explorer, a fishery expert, a fish-culturist, an active administrator of scientific institutions and an adviser of the federal government in scientific affairs,—for Baird was all these and more.

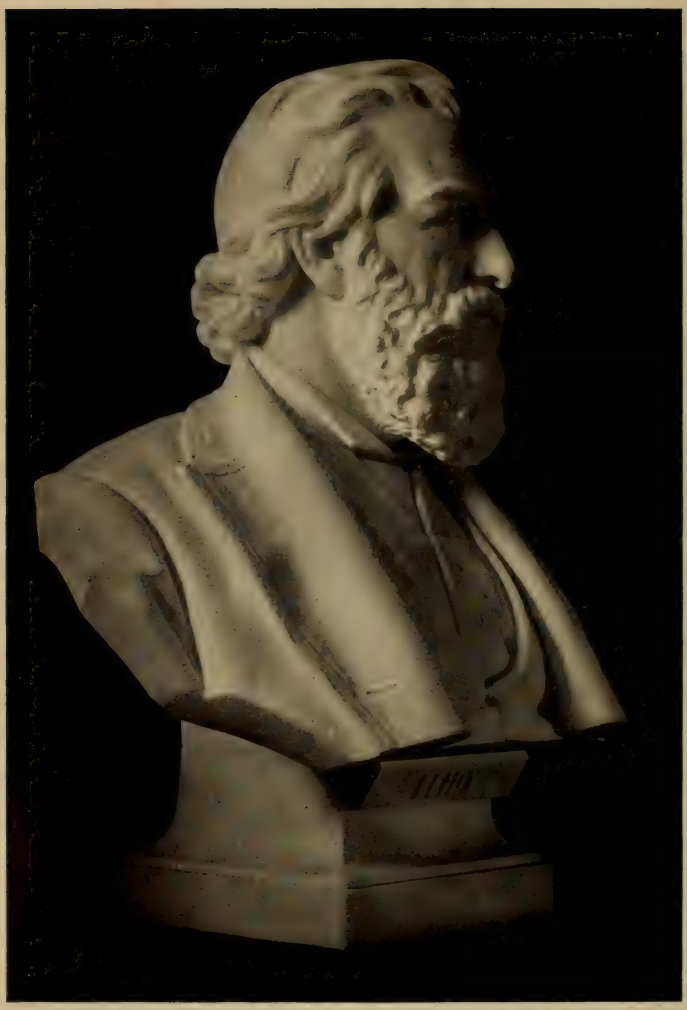
We freely acknowledge today the debt that science owed Baird alive and now owes his memory, especially for his inestimable services as assistant secretary and later as secretary of the Smithsonian Institution, as director of the National Museum and as head of the Commission of Fish and Fisheries. Among all the establishments with which he was connected, this last was preëminently and peculiarly his own.

It was conceived by him and created for him, and it would almost appear that he was created for it, for certainly no other person of his day and generation was so admirably fitted for the task of organizing this bureau and of executing the duties that grew out of its functions as successively enlarged by Congress. Insisting on scientific investigations and knowledge as the essential basis for all current and prospective utilitarian work, he drew around him a corps of eminent biologists and physicists; he established laboratories; he laid plans for the systematic study of our interior and coastal waters; he had vessels built that were especially designed and equipped for exploration of the seas. While he thus inaugurated operations which have been of lasting benefit to the fisheries, at the same time he became the foremost promoter and exponent of marine research; and the knowledge we today possess of oceanic biology and physics is directly or indirectly due to Baird more than to any other person. The rapid development of piscicultural science under his guidance gave to the United States the foremost place among the nations in maintaining and increasing the aquatic food supply by artificial means; and it was no perfunctory tribute when in 1880, at the International Fishery Exhibition held in Berlin, Emperor William awarded the grand prize to Baird as "the first fish-culturist in the world."

The spirit of Baird influences the Bureau of Fisheries today, as it does all the other institutions with which he was associated; and since his death nearly twenty years ago, the good that has been accomplished in the interest of fish culture and the fishing industry, and in the conduct and encouragement of scientific work, has been in consequence of the foundations he laid, the policy he enunciated and the example he set.

But conspicuous as were his services to science and mankind; faithful and unselfish as was his devotion to the executive responsibilities imposed on him; beautiful as was his personal character, I conceive that his most enduring fame may result from the enthusiasm with which he inspired others, and the encouragement and opportunity that he afforded to all earnest workers. The recipients of his aid can be numbered by hundreds, and many of them are today his worthy successors in various fields; and their places in turn will gradually be taken by a vast number of men and women who will perpetuate his memory by efficiently and reverently continuing his work.

This evidence of the donor's beneficence is a noble and impressive



JOSEPH LEIDY

Born, Philadelphia, September 9, 1823
Died, Philadelphia, April 30, 1891

Anatomist, zoölogist, palæontologist

Noted for pioneer work among the fossil vertebrates of western United States

memorial of one who merited his country's profoundest gratitude; but the bust signifies something more, for it is a recognition of that zeal, fidelity, self-sacrifice, intelligence and strength in the American character so preëminently typified by Spencer Fullerton Baird.

JOSEPH LEIDY.

By William Keith Brooks.

Joseph Leidy was born in Philadelphia; there he passed his three score years and ten, and there he died. For forty-five years he was an officer in the Philadelphia Academy of Natural Science, and for forty years a professor in the University of Pennsylvania. His character was simple and earnest, and he had such a modest opinion of his talents and of his work, that the honors and rewards that began to come to him in his younger days, from learned societies in all parts of the world, and continued to come for the rest of his life, were an unfailing surprise to him.

His knowledge of anatomy and zoölogy and botany and mineralogy was extensive and accurate and at his ready command. Farmers and horticulturists came to him and learned how to check the ravages of destructive insects; physicians sent rare or new human parasites and were told their nature and habits and the best means of prevention; jewelers brought rare gems and learned their value. His comments, at the Academy, on the recent additions to its collections gave a most impressive illustration of his ready command of his vast store of knowledge of natural history.

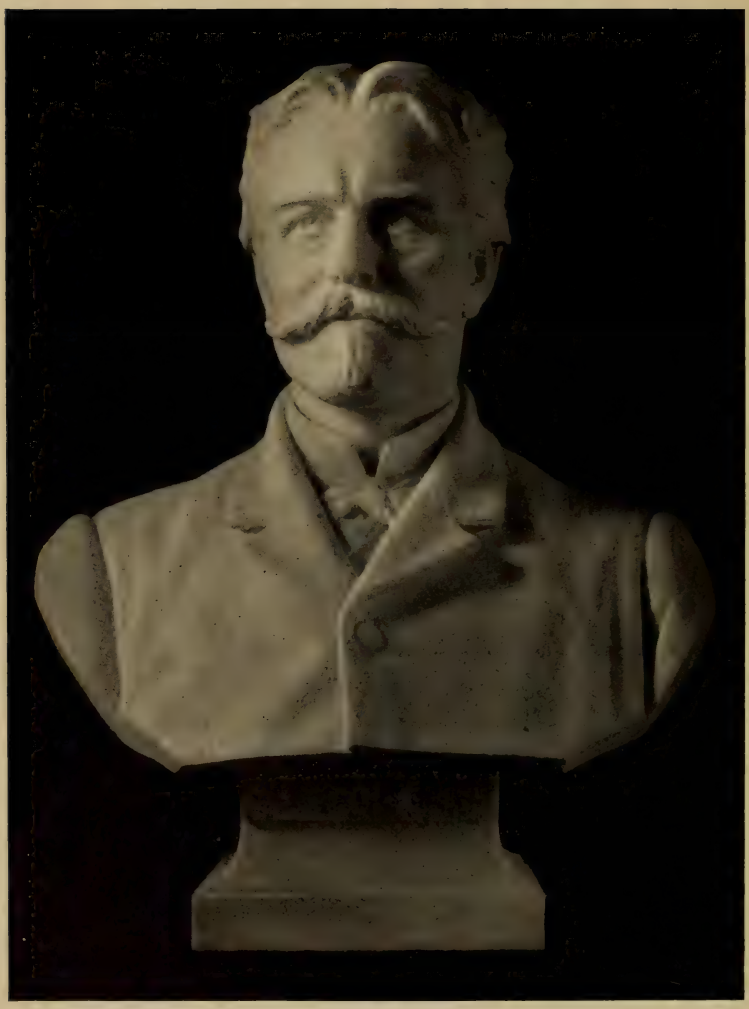
Leidy wrote no books, in the popular meaning of the word. He undertook the solution of no fundamental problem of biology. There are few among his six hundred publications that would attract unscientific readers, or afford a paragraph for a newspaper. They are simple and lucid and to the point. Most of them are short, although he wrote several more exhaustive monographs. They cover a wide field, but most of them fall into a few groups. Many deal with the parasites of mammals — among them, one in which his discovery of trichena in pork is recorded.

Two hundred and sixteen, or about one third, of his publications are

on the extinct vertebrates of North America. His first paper on palæontology was published in 1846, and his last in 1888, as the subject occupied him for more than forty years. He laid, with the hand of a master, the foundation for the palæontology of the reptiles and mammals of North America, and we know what a wonderful and instructive and world-renowned superstructure his successors have reared upon his foundation. It was this work that established his fame and brought his honors and rewards. They who hold it to be his best title to be enrolled among the pioneers of science in America are in the right, in so far as the founder of a great department of knowledge is most deserving of commemoration; but I do not believe it was his most characteristic work.

I can mention but one of the results of his study of American fossils. He showed, in 1846, that this continent was the ancestral home of the horse, and he sketched, soon after, the outline of the story of its evolution which later workers have made so familiar.

More than half his papers are on a subject which seems to me to contain the lesson of his life. Like Gilbert White, he was a home naturalist, devoted to the study of the natural objects that he found within walking distance of his home, but he penetrated far deeper into the secrets of the living world about him than White did, finding new wonders in the simplest living being. In the intestine of the cock-roach, and in that of the white ant, he found wonderful forests of microscopic plants that were new to science, inhabited by minute animals of many new and strange forms. His beautifully illustrated memoir on *A Flora and Fauna Within Living Animals* is one of the most remarkable works in the whole field of biological literature. Another memoir gives the results of his study of the anatomy of snails and slugs. The inhabitants of the streams and ponds in the vicinity of his home furnished an unfailing supply of material for research and discovery, and many of his publications are on aquatic animals. He finally became so much interested in the fresh-water rhizopods that he abandoned all other scientific work in order to devote his attention exclusively to these animals. His results were published in the memoir on *The Fresh-water Rhizopods of North America.* This is the most widely known of his works. It is, and must long be, the standard and the classic upon its subject. I have no time to dwell upon his work as the naturalist of the home — his best and most characteristic work. Its lesson to



EDWARD DRINKER COPE

Born, Philadelphia, July 28, 1840
Died, Philadelphia, April 12, 1897

Palæontologist, biologist, philosopher

Noted for his discoveries among the vertebrate fossils of western United States and his deductions from their study

later generations of naturalists seems to me to be that one may be useful to his fellow-men and enjoy the keen pleasure of discovery and come to honor and distinction, without visiting strange countries in search of rarities, without biological stations and marine laboratories, without the latest technical methods, without grants of money, and, above all, without undertaking to solve the riddles of the universe or resolving biology into physics and chemistry.

If one have the simple responsive mind of a child or of Leidy, he may, like Leidy, "find tongues in trees, books in the running brooks, sermons in stones and good in everything."

EDWARD DRINKER COPE.

By Henry Fairfield Osborn.

In the marble portrait of Edward Drinker Cope, you see the man of large brain, of keen eye and of strong resolve, the ideal combination for a life of science, the man who scorns obstacles, who while battling with the present looks above and beyond. The portrait stands in its niche as a tribute to a great leader and founder of American palæontology, as an inspiration to young Americans. In unison with the other portraits its forcible words are: "Go thou and do likewise."

Cope, a Philadelphian, born July 28, 1840, passed away at the early age of fifty-seven. Favored by heredity, through distinguished ancestry of Pennsylvania Quakers, who bequeathed intellectual keenness and a constructive spirit. As a boy of eight entering a life of travel and observation, and with rare precocity giving promise of the finest qualities of his manhood. Of incessant activity of mind and body, tireless as an explorer, early discovering for himself that the greatest pleasure and stimulus of life is to penetrate the unknown in Nature. In personal character fearless, independent, venturesome, militant, far less of a Quaker in disposition than his Teutonic fellow citizen Leidy. Of enormous productiveness, as an editor conducting the *American Naturalist* for nineteen years, as a writer leaving a shelf-full of twenty octavo and three great quarto volumes of original research. A man of fortitude, bearing material reverses with good cheer, because he lived in the

world of ideas and to the very last moment of his life drew constant refreshment from the mysterious regions of the unexplored.

In every one of the five great lines of research into which he ventured, he reached the mountain peaks where exploration and discovery guided by imagination and happy inspiration gave his work a leadership. His studies among fishes alone would give him a chief rank among zoölogists, on amphibians and reptiles there never has been a naturalist who has published so many papers, while from 1868 until 1897, the year of his death, he was a tireless student and explorer of the mammals. Among animals of all these classes his generalizations marked new epochs. While far from infallible, his ideas acted as fertilizers on the minds of other men. As a palæontologist, enjoying with Leidy and Marsh that Arcadian period when all the wonders of our great West were new, from his elevation of knowledge which enabled him to survey the whole field with keen eye he swooped down like an eagle upon the most important point.

In breadth, depth and range we see in Cope the very antithesis of the modern specialist, the last exponent of the race of the Buffon, Cuvier, Owen and Huxley type. Of ability, memory and courage sufficient to grasp the whole field of natural history, as comparative anatomist he ranks with Cuvier and Owen; as palæontologist with Owen, Marsh and Leidy — the other two founders of American palæontology; as natural philosopher less logical but more constructive than Huxley. America will produce men of as great, perhaps greater genius, but Cope represents a type which is now extinct and never will be seen again.

Guide Leaflet No. 25

American Museum of Natural History

AMERICAN MUSEUM OF NATURAL HISTORY

The Foyer Collection of Meteorites

By EDMUND OTIS HOVEY, Ph. D.
Associate Curator of Geology

GUIDE LEAFLET NO. 26

DECEMBER, 1907

American Museum of Natural History

Seventy-seventh Street and Central Park West, New York City

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WESTERN HALF OF FOYER.

Showing the following Meteorites: Ahnighito, Brenham, Forest City, The Dog, The Woman.

THE METEORITES

IN THE FOYER OF THE

American Museum

OF

NATURAL HISTORY

By EDMUND OTIS HOVEY, Ph. D.

ASSOCIATE CURATOR OF GEOLOGY

NO. 26

OF THE

GUIDE LEAFLET SERIES

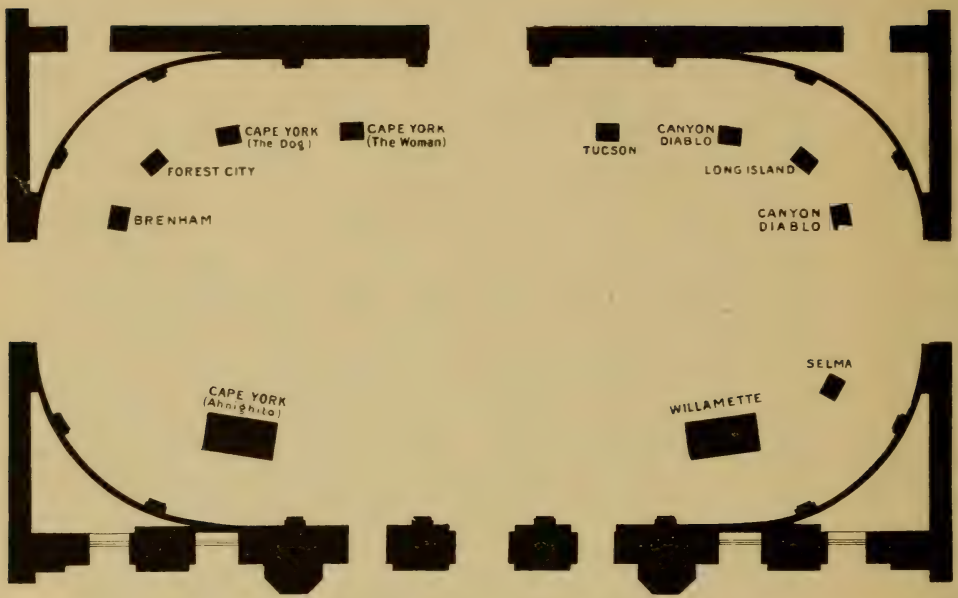
OF THE

AMERICAN MUSEUM OF NATURAL HISTORY

EDMUND OTIS HOVEY, EDITOR

New York. Published by the Museum. December, 1907

NORTH



THE FOYER. NO. 104.

First (Ground) Floor, Central Section of Building.

TABLE OF CONTENTS.

	PAGE		PAGE
Introduction	5	Willamette	27
Classification	8	Canyon Diablo	28
Chemical Composition	12	Tucson	30
Mineral Constituents	13	Brenham	32
Essential Constituents	14	Forest City	33
Accessory Constituents	17	Long Island (Kansas)	35
Surface Characteristics	19	Selma	39
The Cape York Meteorites	23		

LIST OF ILLUSTRATIONS.

	PAGE		PAGE
Western Half of Foyer	2	Section of Ahnighito	24
The Foyer. No. 104 (*Plan*)	4	Willamette	25
Ahnighito, The Great Cape York Meteorite	9	Section of Willamette	27
Widmanstätten Lines, or Figures	14	Canyon Diablo	29
Canyon Diablo. Etched Section Showing Widmanstätten Lines	15	Tucson, or "Signet"	31
Cape York "The Woman"	21	Brenham	32
Cape York "The Dog"	23	Forest City	34
		Long Island	36
		Selma	37

THE METEORITES IN THE FOYER OF THE AMERICAN MUSEUM OF NATURAL HISTORY.[1]

By Edmund Otis Hovey, Ph. D.

Associate Curator of Geology.

Introduction.

SCARCELY a century ago the scientific and even the popular world scoffed at the idea that masses of matter could possibly come from outer space (or "heaven") and strike the surface of the earth,— in other words that stones could fall from the sky. Even at the present time, although it is well known that occasionally masses of metal and stone — "meteorites" — do fall from the sky, there is much misinformation current in regard to their character and the conditions under which they have come to the earth.

Livy, Plutarch and other early historians mention several stones which had been seen to fall from the sky. Among these were a stone which fell in Phrygia and was kept there for centuries until it was removed to Rome about 204 B. C. with imposing ceremonies; a shower of stones that fell in the Alban Mountains near Rome about 652 B. C., and a stone that fell in Thrace in the fifth century B. C. and was known to Pliny five hundred years later. The image of the goddess Diana which was preserved at Ephesus is said to have "fallen down from Jupiter" and was probably a meteorite, and idol known as the Venus of Cyprus seems likewise to have had the same origin. Stones which have fallen from the sky have been regarded as being of miraculous origin and have been worshiped by many primitive peoples. They have been viewed with awe too by tribes and nations which could not be considered primitive, including some in India, China and Japan.

Arguments which form strange reading at the present day were advanced by eminent scientists against the idea that any bodies could come to the earth from space, and French scientists were particularly

[1] *Guide Leaflet No. 26* of the American Museum series.

vehement in their denial of such origin. Even the famous chemist Lavoisier was one of a committee of three who presented to the French Academy in 1772 a report upon a stone, the fall of which was said to have occurred at Lucé four years previously. They recorded their opinion that the stone was an ordinary one which had been struck by lightning. It was, nevertheless, a true meteorite.

Early in the year 1794 Professor Chladni, a renowned German physicist, published a thesis in which he collated many accounts of bodies which had been said to have fallen from the sky, discussed the nature of the bodies themselves and expressed the conviction that bodies could and did come to our earth from space. Chladni devoted particular attention to the iron-and-stone mass known as the "Medwedewa" meteorite and the iron mass known as Campo del Cielo. The former of these was first described by the traveler Pallas, who saw it in the year 1772 at the city of Krasnojarsk, Siberia. The latter was found by Indians in the interior of Argentina, South America, and was first visited in the year 1783 by Don Michael Rubin de Celis, who calculated the weight of the mass to be 30,000 pounds.

As if in direct confirmation of Chladni's theory, a shower of stones fell at Siena, Italy, on June 16, 1794, and the occurrence is thus described in connection with the account of an eruption of Vesuvius by Sir William Hamilton[1]:

"I must here mention a very extraordinary circumstance indeed, that happened near Sienna in the Tuscan state, about 18 hours after the commencement of the late eruption at Vesuvius on the 15th of June, though that phenomenon may have no relation to the eruption; and which was communicated to me in the following words by the Earl of Bristol, bishop of Derry, in a letter dated from Sienna, July 12th, 1794: 'In the midst of a most violent thunder-storm, about a dozen stones of various weights and dimensions fell at the feet of different people, men, women, and children; the stones are of a quality not found in any part of the Siennese territory; they fell about 18 hours after the enormous eruption of Vesuvius, which circumstance leaves a choice of difficulties in the solution of this extraordinary phenomenon: either these stones have been generated in this igneous mass of clouds, which produced such unusual thunder, or, which is equally incredible, they were thrown from Vesuvius at a distance of at least 250

[1] Philosophical Transactions of the Royal Society of London. Abr. ed., 1809, vol. XVII, p. 503.

miles; judge then of its parabola. The philosophers here incline to the first solution. I wish much, Sir, to know your sentiments. My first objection was to the fact itself; but of this there are so many eye-witnesses, it seems impossible to withstand their evidence, and now I am reduced to a perfect scepticism.' His lordship was pleased to send me a piece of one of the largest stones, which when entire weighed upwards of 5 lb.; I have seen another that has been sent to Naples entire, and weighs about 1 lb. The outside of every stone that has been found, and has been ascertained to have fallen from the cloud near Sienna, is evidently freshly vitrified, and is black, having every sign of having passed through an extreme heat; when broken, the inside is of a light grey color mixed with black spots, and some shining particles, which the learned here have decided to be pyrites, and therefore it cannot be a lava, or they would have been decomposed."

Scientists, however, are often hard to convince, and some of that day contended that the Siena stone had been formed in the air by condensation of the particles of dust in an eruption cloud from Vesuvius, in spite of the fact that Siena is 250 miles distant from the volcano and that the largest stone of the shower weighed 7½ pounds, while several weighed more than 1 pound each. Even the 56-pound stone which fell December 13, 1795, at Wold Cottage near Scarborough, Yorkshire, England, almost at the feet of a laborer, did not dislodge this theory from the mind of Edward King, its originator.

The cloud theory was completely disproved at Krakhut near Benares, India, on December 19, 1798, when, directly after the passage of a ball of fire through the air, a heavy explosion or a series of explosions was heard and many stones[1] fell from a sky which had been perfectly cloudless for a week before the event and remained so for many days afterward. Even these facts, however, did not fully convince the scientists of France and it required the occurrence of the meteoritic shower of L'Aigle, France, April 26, 1803, for final proof.[2] L'Aigle is easily accessible from Paris and M. Biot, a noted physicist was sent at once to investigate the matter. Biot learned that on the day mentioned a violent explosion occurred in a practically clear sky in the vicinity of

[1] Represented in the general meteorite collection, Morgan Hall, No. 404 of the fourth floor of this building, by a small fragment one fourth of an ounce (8 grammes) in weight.

[2] A fragment of L'Aigle weighing 5 ounces (157 grammes) is in the general collection.

L'Aigle which was heard over an area seventy five miles in diameter directly after a swiftly moving fire-ball had been seen to pass through the air. The explosion, or series of explosions, was immediately followed by the fall of two or three thousand stones within an elliptical area about $6\frac{1}{4}$ miles long and $2\frac{1}{2}$ miles wide. The largest of the stones weighed 20 pounds, the next largest $3\frac{1}{2}$ pounds, but most of the fragments were very small. The occurrence at L'Aigle proved the correctness of another of Chladni's theories, which was that "fire balls" in the sky were nothing more or less than meteorites in flight.

The oldest still existing meteorite of the fall of which we have an exact record is that of Ensisheim, in Elsass, Germany.[1] An ancient document states:

"On the sixteenth of November, 1492, a singular miracle happened: for between 11 and 12 in the forenoon, with a loud crash of thunder and a prolonged noise heard afar off, there fell in the town of Ensisheim a stone weighing 260 pounds. It was seen by a child to strike the ground in a field near the canton called Gisguad, where it made a hole more than five feet deep. It was taken to the church as being a miraculous object. The noise was heard so distinctly at Lucerne, Villing, and many other places, that in each of them it was thought that some houses had fallen. King Maximilian, who was then at Ensisheim, had the stone carried to the castle; after breaking off two pieces, one for the Duke Sigismund of Austria and the other for himself, he forbade further damage, and ordered that the stone be suspended in the parish church." [2]

Within the past century many stones and some masses of iron have been seen to fall from the sky and afterwards have been collected and are now in cabinets, while several hundred specimens have been found which are so much like the positively known meteorites that they have been classed with them and are jealously guarded in collections.

Classification.

Meteorites are generally divided into three classes according to their mineral composition:

1. "Siderites," or iron meteorites, which consist essentially of an alloy of iron and nickel;

[1] A fragment of this meteorite weighing about four ounces (129 grammes) is in the general meteorite collection.

[2] Fletcher. An Introduction to the study of Meteorites. P. 19. 1888.

AHNIGHITO. THE GREAT CAPE YORK METEORITE.

Weight, more than 36.5 tons. The largest and heaviest meteorite known.

2. "Siderolites," or iron-stone meteorites, which are formed of a nickel-iron sponge, or mesh, containing stony matter in the interstices;
3. "Aërolites," or stone meteorites, which are made up mainly of stony matter, but almost always contain grains of nickel-iron scattered through their mass.

The line of demarcation between these classes is not always sharp, and there are many subordinate kinds of aërolites.

Countless numbers of meteoritic bodies, mostly of minute size, must exist within the boundaries of the solar system, since from fifteen to twenty millions of them enter the earth's atmosphere every day. Almost all of these are dissipated in our atmosphere through heat produced by friction with the air, so that the only evidence of their presence is a trail of light across the sky. This usually is visible only at night, and is familiar to all as a shooting star or meteor. Shooting stars are to be seen almost every evening, but they are particularly abundant during August and November. Sometimes the November shower of meteors has been so pronounced that the sky has seemed fairly to radiate lines of fire, an effect far surpassing in brilliance the most ambitious artificial fire works. Not one in a hundred million of these shooting stars, however, reaches the earth in a recognizable mass; in fact, there are records of only about 685 known meteorites which are represented in museums and private cabinets.

The weight of known meteorites varies between wide limits. The lightest independent mass is a stone meteorite weighing about one sixth of an ounce called Mühlau from the town in the vicinity of Innsbruck, Austria, near which it was found in 1877; the heaviest mass known is Ahnighito, of the Foyer collection, an iron meteorite weighing more than thirty-six and one half tons which came from Cape York, Greenland. Some showers of meteorites have furnished even smaller individuals than Mühlau. Forest City, well represented in the Foyer collection, has been found in fragments weighing one twentieth of an ounce. Pultusk is a famous fall and the smallest of the "Pultusk peas," as the material is called, weigh less than one thirtieth of an ounce each, while Hessle fell in a veritable rain of meteoritic dust, the smallest particles of which weigh about one four hundred twenty-fifth of an ounce and could never have been found had they not fallen on an ice-covered lake, where they were readily seen and recognized.

Meteoritic masses are almost certainly extremely cold during their existence in outer space, but when they come into the earth's atmosphere friction with the air raises the temperature of the surface to the melting point, producing a great amount of dazzling light as well as superficial heat. In spite of this surface fusion, it is highly probable that the duration of the aërial flight of a meteorite is so short that in many cases the interior does not become even warm.[1]

The rapid heating of the exterior and the differences of temperature between different parts of a meteorite often lead to its rupture before it reaches the ground. This is particularly the case with stone meteorites, the iron meteorites being tough enough usually to withstand the fracturing agencies. Most of the meteorites which have burst have furnished only two or three fragments, so far as known, but a few have furnished many, while there have been found 700 pieces of Hessle, 1000 pieces of Forest City, several thousand each of Knyahinya and L'Aigle, and about one hundred thousand each of Mocs and Pultusk. The name "stone shower" has been appropriately given to the falls comprising many individuals. "Iron showers" from bursting siderites are much rarer than the stone showers, only six are known to have occurred, among which Canyon Diablo leads, several thousands of fragments of this famous fall having been found.

The breaking up of a meteorite is accompanied by an explosion or series of explosions, and often these are startling in their sharpness and intensity, when they occur near the earth. Forest City, 268 pounds of which have been found, just before falling burst in a series of explosions which were heard over an area two hundred miles in diameter. There were three distinct detonations connected with the fall near Butsura, Bengal, which were heard at Goruckpur sixty miles away, although the meteorite was a small one, less than fifty pounds of it having been found. The occurrences at Krakhut, L'Aigle and Ensisheim have already been mentioned.

Chemical Composition.

Some forty one elements, four of which are gases, are said to occur in meteorites, but several of these may be regarded as doubtful. The

[1] See also page 18.

most abundant have been arranged by Dr. O. C. Farrington[1] in the following order of importance:

1. Iron	3. Silicon	5. Nickle	7. Calcium
2. Oxygen	4. Magnesium	6. Sulphur	8. Aluminum

The other elements of particular importance in this connection are carbon, chlorine, chromium, cobalt, copper, hydrogen, manganese, nitrogen, phosphorus, potassium and sodium.

Mineral Constituents.

Seven elements have been found in meteorites in the elemental or uncombined state. They are iron, nickel, cobalt and copper in the form of alloys, carbon, hydrogen and nitrogen. With these exceptions, the constituents of meteorites are chemical compounds and all but six of the whole list have their exact equivalents in minerals which are found in the crust of the earth.

According to most authorities the constituents of meteorites may be divided into essential and accessory components as follows[2]:

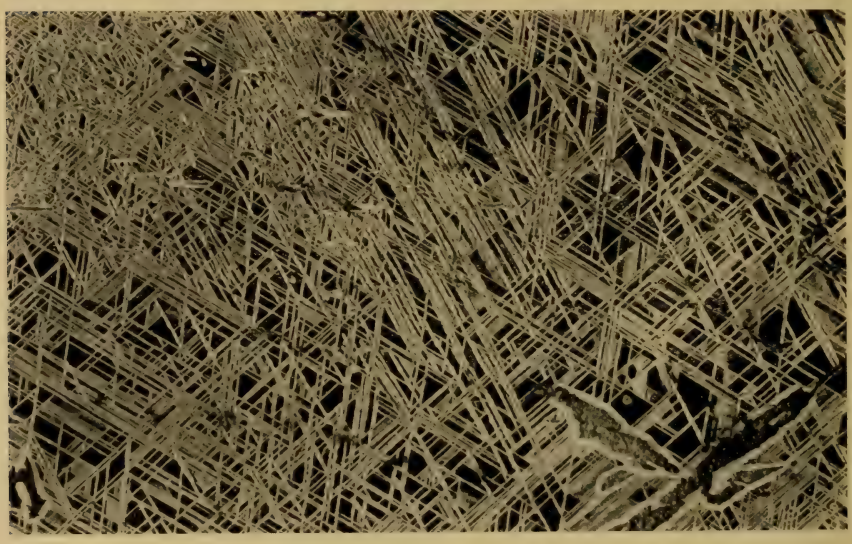
Essential.	*Accessory.*
Nickel-iron	*Schreibersite
Olivine (chrysolite)	Diamond
Pyroxenes (Orthorhombic)	Graphite (Cliftonite)
Pyroxenes (Monoclinic)	Hydro-carbons.
Feldspar (Plagioclase)	Cohenite
*Maskelynite.	*Moissanite
	*Troilite
	Pyrrhotite
	*Daubréelite
	*Oldhamite
	Tridymite
	Chromite
	Magnetite
	Osbornite
	Lawrencite
	Glass

[1] Journal of Geology. Vol. IX, p. 394. 1901.

[2] E. Cohen. Meteoritenkunde I, p. 322. 1894. The asterisk indicates the minerals which are peculiar to meteorites and are not known to occur in the earth's crust.

Essential Constituents.

The iron of meteorites is always alloyed with from 6 to 20 per cent of nickel. This "nickel-iron," as it is commonly called, is usually crystalline in texture, and when it is cut, polished and "etched" a beautiful network of lines is brought out, indicating plates which lie in positions determined by the crystalline character of the mass. This network of lines constitutes what are called the Widmanstätten figures, from the name of their discoverer. When these figures are strongly developed, the meteoritic origin of the iron cannot be questioned, but their absence does not necessarily disprove such an origin. Native iron of terrestrial

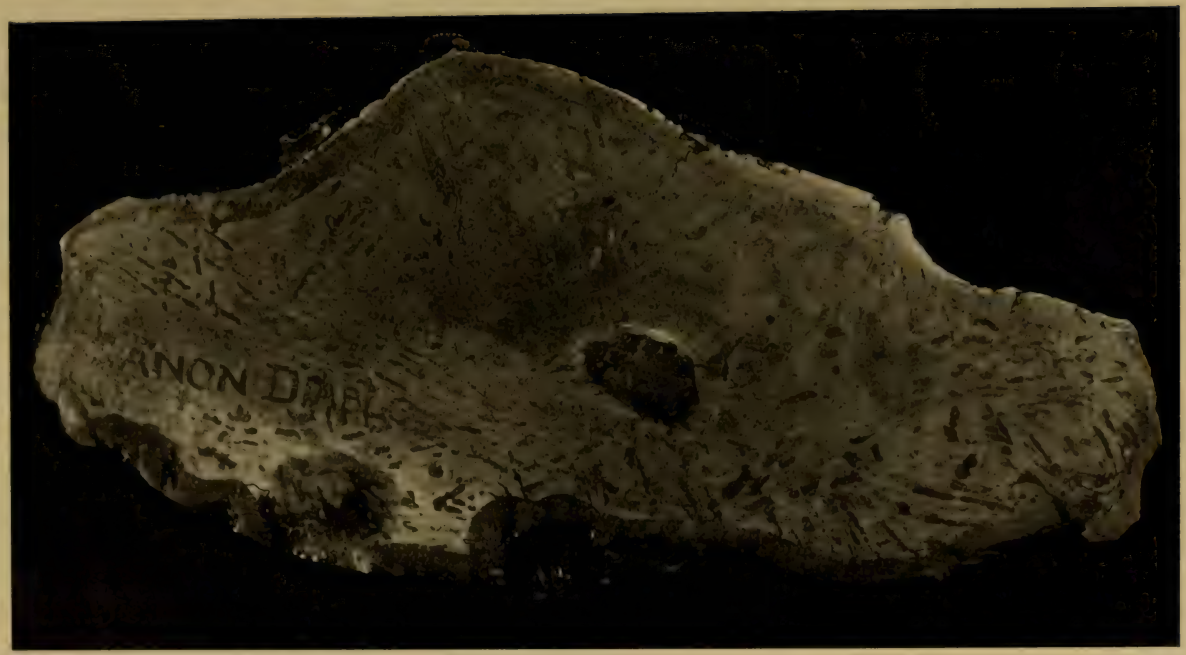


WIDMANSTÄTTEN LINES, OR FIGURES.

Carleton Iron Meteorite. Natural size. In this iron the plates are very thin.

origin is extremely rare and has been found almost exclusively at Disco Island and immediate vicinity on the west coast of Greenland. The Disco, or Ovifak, iron contains less nickel than meteoritic iron, while other terrestrial nickel-irons (*i. e.* awaruite and josephinite) contain much more. Small quantities of metallic cobalt are also alloyed with the nickel and a little copper is sometimes found in the same association.

Next to nickel-iron the mineral olivine, or chrysolite, is the most important constituent. This is a silicate of magnesium, always con-



15 CANYON DIABLO. ETCHED SECTION SHOWING WIDMANSTÄTTEN LINES.

A diamond was found in the black spot in this section.

taining some iron, which occurs in all the siderolites and most of the aërolites, sometimes comprising a considerable portion of their mass. It is a dark yellowish-green to black, glassy mineral usually occurring as rounded or angular grains, but sometimes as crystals. It is prominent in a slice of Brenham in the Foyer collection, where it forms glassy grains in a mesh of nickel-iron. Olivine is the gem, peridot.

The minerals belonging to the group known as orthorhombic pyroxenes are next to olivine in point of abundance. Chemical analyses show that all gradations are present from the colorless enstatite to the almost black hypersthene members of the group. The monoclinic pyroxenes, which are important constituents of terrestrial igneous rocks, are represented in meteorites by only two forms, an iron-alumina pyroxene like common augite and one nearly free from iron and without alumina which is to be compared with diopside. The augite-like mineral is brown to green in color and occurs usually in grains or splinters rarely in crystals. It has been found in many meteorites, but diopside has been identified only once with certainty.

The great feldspar series has been identified in meteorites in four of its forms, namely: anorthite, albite, oligoclase and labradorite. Of these, anorthite has been found forming a large part (35 per cent.) of some meteorites and measurable crystals have been obtained, but in most cases where feldspar occurs in a meteorite, it has been possible to go no farther than to identify it as belonging to the plagioclase section of the mineral group.

Maskelynite is a transparent, colorless, glassy mineral. In chemical composition it is related to the terrestrial species leucite, but it is a distinct form and thus far is known only from meteorites. It is not known to occur in any of the meteorites displayed in the Foyer.

Accessory Constituents.

Schreibersite is a phosphide of iron, nickel and cobalt which is probably peculiar to meteorites. It is tin-white in color, changing to bronze-yellow or steel gray on exposure to the air. In structure it is granular, flaky, crystalline or needle-like. Next to nickel-iron schreibersite is the most generally disseminated constituent of siderites and forms some of the shining lines to be seen on etched sections.

Carbon occurs in at least three forms in meteorites, as the diamond,

as graphite (cliftonite) and as hydrocarbons. Diamonds were first found in Canyon Diablo in 1891. They are extremely minute in size but recognizable crystals have been obtained. Graphite (cliftonite) occurs usually in nodules and only in siderites in particles that are large enough for easy examination. The material is very fine. The cliftonite form of graphite is considered by most authorities to be a pseudomorph after diamond.

Hydrocarbons of several kinds have been found in meteorites. According to Cohen[1] they may be grouped into three classes: (1) compounds of carbon and hydrogen alone; (2) compounds of carbon, hydrogen and oxygen; (3) compounds of carbon, hydrogen and sulphur. None of the meteorites in the Foyer collection is known to contain any hydrocarbon, but the fact that any meteorite should contain such substances is of great scientific interest. It is pretty clear that they belong to the pre-terrestrial history of the masses; hence, since they are readily combustible or volatile, the meteorites that contain them cannot have been heated to high temperatures, at any rate, subsequent to the formation of the compounds. This is an additional argument in support of the statement already made that the heating of meteorites during aërial flight is, in many instances at least, only superficial. Furthermore, the existence of hydrocarbon compounds in meteorites, where no life can have existed, shows that organisms are not absolutely necessary to the formation of such compounds in the earth's crust.

Cohenite, which is a carbide of iron, nickel and cobalt, is tin-white in color and looks like schreibersite. It is much rarer, however, and occurs in isolated crystals. The only terrestrial occurrence of cohenite is in the basaltic iron of Greenland. Moissanite, the natural carbide of aluminum corresponding to the artificial carborundum, has thus far been found only in Canyon Diablo, where it occurs in microscopic crystals. It is the latest discovery among the constituents of meteorites, having been found in 1905 by Henri Moissan.

As far as investigations have been carried, heating develops the fact that meteorites contain gases condensed within them, either by occlusion in the same way that platinum and zinc absorb hydrogen or by some form of chemical union. According to Cohen[2] the following gases have

[1] Meteoritenkunde. Heft I, p. 159.
[2] Meteoritenkunde. Heft I, p. 169

been found: hydrogen, carbon dioxide, carbon monoxide, nitrogen and marsh gas (light carburetted hydrogen).

Troilite is common in meteorites and constitutes brass- or bronze-yellow nodules, plates and rods which are to be seen in nearly every section, particularly of siderites. The mineral is usually considered to be the simple sulphide of iron, FeS, but its exact chemical composition and crystalline structure are still matters of investigation and dispute. Canyon Diablo and Willamette contain, or contained, much troilite in the shape of rods, and the fusion and dissipation of this mineral during the aërial flight of the masses gave rise to some of the holes which penetrate them, and the same statement is true of many other meteorites. Pyrrhotite, the magnetic sulphide of iron, Fe_{11} S_{12}, occurs in stone meteorites and chiefly in the form of grains. Daubréelite is likewise a sulphide of iron, but it differs from those just mentioned through containing much chromium, giving the chemical formula FeS, Cr_2 S_3. The mineral is peculiar to siderites and siderolites and has never been found in the stone meteorites or in the earth's crust. It occurs in Canyon Diablo, where it may be seen surrounding nodules of troilite as a black shell with metallic luster.

Oldhamite, a sulphide of calcium, CaS; tridymite, a form of silica, SiO_2; chromite, an oxide of iron and chromium, $FeCr_2$ O_4; magnetite, the magnetic oxide of iron, Fe_3 O_4; osbornite, another sulphide or oxysulphide of calcium, and lawrencite a chloride of iron, Fe Cl_2, occur sparingly in some meteorites. Lawrencite manifests itself rather disagreeably through alteration to the ferric chloride, which oozes out of the masses of iron and stands in acrid yellow drops on the surface or runs in streaks to the bottom. Glass like the volcanic glass of terrestrial rocks seems never to be absent from the interior of stone meteorites, but from the nature of the case it is not found in iron meteorites.

Surface Characteristics.

The surface of a newly-fallen meteorite always consists of a thin veneer or crust which differs in marked degree from the interior of the mass. In the case of the siderites, this seems to be a polish due to melting and friction, together with partial oxidation. Some iron meteorites which are known to have lain long in the ground likewise show a crust which is somewhat similar in appearance, but it is due to slow oxidation

or "rusting" in the ground and is called the rust crust. Almost without exception the aërolites are covered with a crust, the appearance of which varies according to the mineral composition of the mass. The crust is almost always black and is usually dull, but sometimes it has high luster. A few meteorites possess a dark-gray crust, and some show crust only in patches.

The crust of the stone meteorites is glassy in character on account of its being composed of silicates which have been cooled rapidly from fusion. This glass, like glasses of volcanic origin, does not long resist the atmospheric agents of decay, hence it is usually missing from those aërolites which have lain long in the earth or it is much decomposed, as may be seen by examining Long Island and Selma in the Foyer collection. The crust varies in thickness on different parts of a meteorite and often shows ridges and furrows which are due to friction with the air. Frequently the ridges or furrows radiate from one or more centers in such manner as to show which side of the mass was forward during its flight through the air. So quickly is the crust formed that even the smallest members of a meteorite shower usually possess a complete crust. In the case of angular fragments the crust on the different sides can usually be distinguished as "primary" or "secondary" according to whether it was a part of the original exterior of the mass or was formed upon the new surfaces exposed by the bursting of the meteorite.

Another common surface characteristic of meteorites is an abundance of shallow depressions or pittings, which on account of their form have been called "thumb marks," or piëzoglyphs. These pittings are so shallow and superficial in character that exposure to the atmosphere obscures or obliterates them in a comparatively short time. The rusting of an iron meteorite may produce similar shallow depressions, as will be seen from an examination of the surfaces of the great hollows in Willamette. The true piëzoglyphs doubtless owe their origin to several different causes, the most potent of which are unequal softening of a mass due to varying chemical composition and rapidly changing pressure and consequent erosion during flight through the atmosphere.

Without going more deeply into the subject in general we may now turn our attention to the Foyer collection.

CAPE YORK.

"The Woman". Weighs 3 tons.

THE CAPE YORK METEORITES,

"AHNIGHITO," OR "THE TENT," "THE WOMAN" AND "THE DOG."

(Siderites.)

For centuries, and perhaps for thousands of years, the three masses of iron known as the Cape York meteorites lay on the north coast of Melville Bay near Cape York, Greenland, but they were seen for the first time by a white person, when they were visited by Commander Robert E. Peary, U. S. N., in 1894 and 1895 under the guidance of Tallakoteah, a member of the Eskimo tribe which up to the early part

CAPE YORK.
"The Dog". Weighs 1100 pounds.

of the nineteenth century had obtained material for knives and other utensils from the masses.

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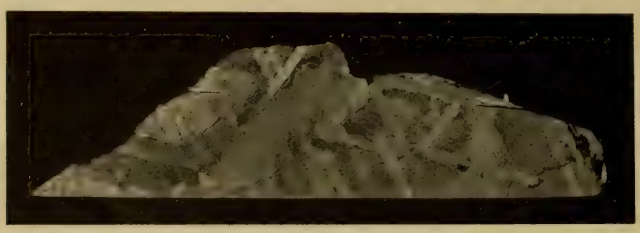
The three meteorites were known as a group to the Eskimo under the

name of "Saviksue" or "The Great Irons," and each had its own name suggested by its shape. The smallest mass, weighing about 1,100 pounds, was called "The Dog"; the next larger mass, weighing about three tons, was named "The Woman," because the shape was thought to suggest the squatting figure of a woman with a babe in her arms and a shawl thrown about her, and the largest mass, weighing more than thirty six and one half tons, was known as "The Tent." The last, however, has been formally christened by the daughter of the explorer with her own name, "Ahnighito." This great mass is 10 feet 11 inches long, 6 feet 9 inches high and 5 feet 2 inches thick.

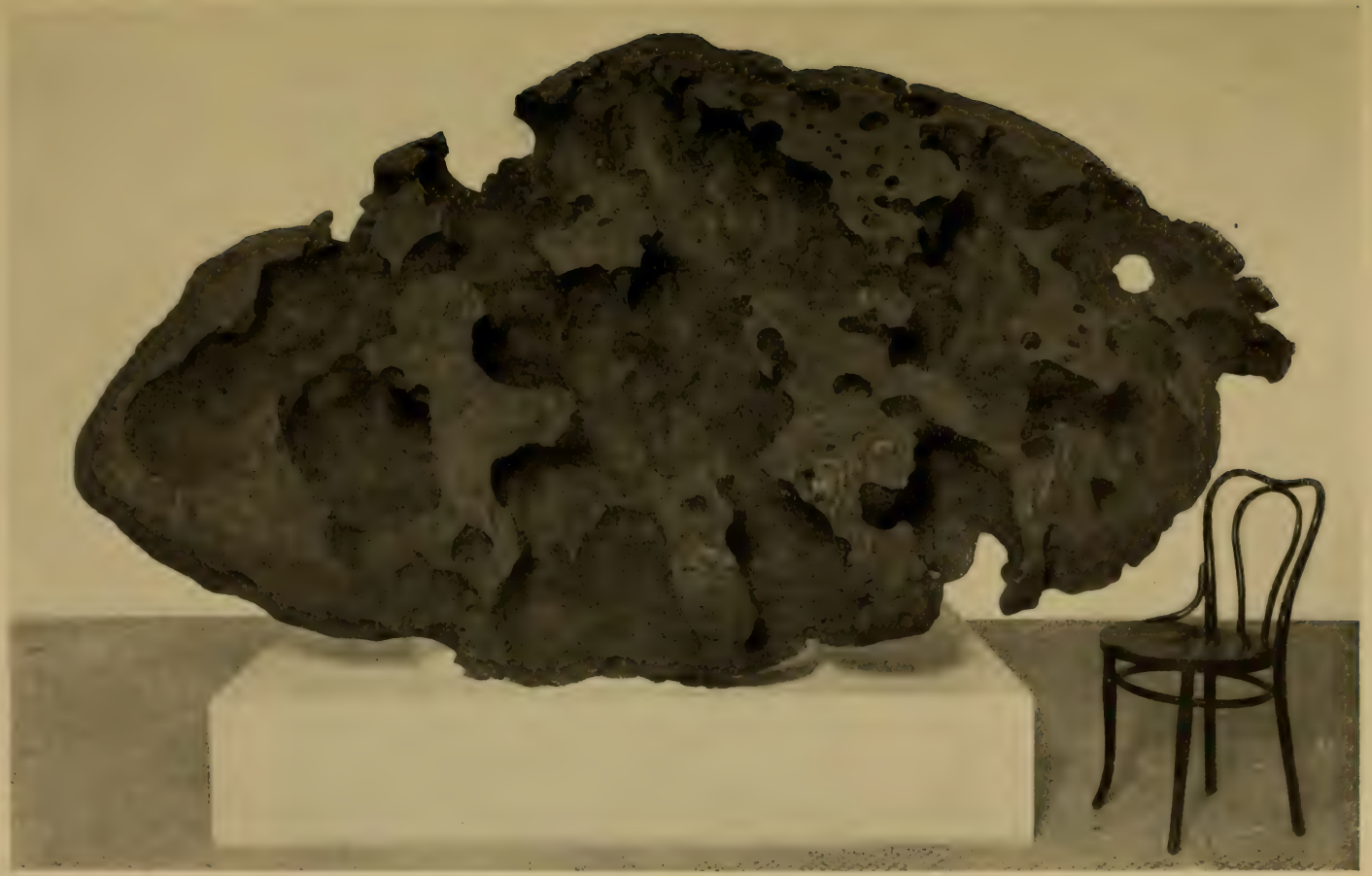
The Woman and the Dog were visited by Peary in 1894 and were obtained the following year after much difficult and exciting work, an incident of which was the breaking up of the cake of ice on which the Woman had been ferried from the shore to ship just as the mass was about to be hoisted aboard. Fortunately there was enough tackle around the meteorite to prevent its loss. In 1895, Commander Peary visited Ahnighito, also, which lay on an island only four miles from the two smaller masses, but he could do little toward its removal. The next year he made another voyage for the purpose of getting the great iron but was unsuccessful. His third attempt was made in 1897, and the meteorite was brought safely to New York in the ship "Hope."



SECTION OF AHNIGHITO. NATURAL SIZE.
Shows broad Widmanstätten lines.

The three masses are closely similar in chemical composition, analyses by J. E. Whitfield giving the following results:

	The Dog.	The Woman.	Ahnighito.
Iron	90.99%	91.47%	91.48%
Nickel	8.27%	7.78%	7.79%
Cobalt	0.53%	0.53%	0.53%



25 WILLAMETTE. (GIFT OF MRS. WILLIAM E. DODGE.)

Length 10 feet, height 6 feet 6 inches. Weight 15.6 tons. Rear side, showing deep pits formed by oxidation.

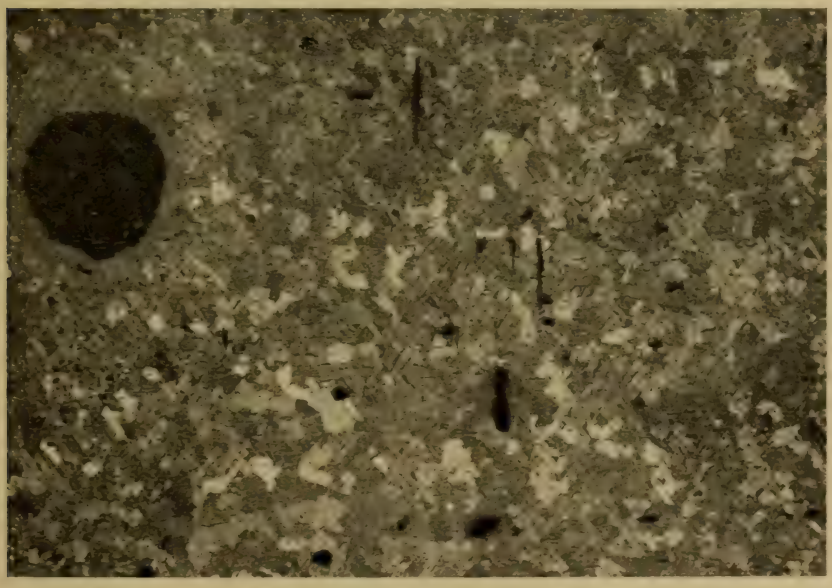
Besides these metals there are present small quantities of copper, sulphur, phosphorus and carbon. The similarity in chemical composition and the close proximity in which the masses lay when found indicate the probability that they are parts of the same fall.

WILLAMETTE

(*Siderite.*)

GIFT OF MRS. WILLIAM E. DODGE.

This is the most interesting iron meteorite, as to external characteristics, which has ever been discovered, and it is the largest ever found in the United States. Its chief dimensions are, length 10 ft., height



SECTION OF WILLAMETTE.

6 ft. 6 in., thickness, 4 ft. 3 in. On the railroad scales in Portland, Oregon, the net weight was shown to be 31,107 lbs.

Willamette was discovered in the autumn of 1902 in the forest about nineteen miles south of Portland, by two prospectors who were searching for ledges likely to contain mineral wealth, particularly gold or silver.

The finders at first supposed that they had come upon a ledge of solid iron, but the meteoritic character of the mass was soon ascertained. Later one of the prospectors removed the meteorite to his own ranch three-quarters of a mile distant, but the owners of the land on which it had been found instituted suit for its recovery, and the contest was carried to the supreme court of the State before the finder relinquished his claim. The specimen was received at the Museum in April, 1906.

The most striking characteristic of Willamette, next to its size, is the series of hollows and deep pits which indent its surface. The broad shallow hollows on the front side, "brustseite," (side now turned toward the wall) were probably caused by friction against the atmosphere and consequent melting and flowage of the iron during the flight of the meteorite through the air. The deep pot-like pits on the rear side (the side now facing the center of the Foyer) are most probably due to rusting while the meteorite was lying in the ground where it fell, and they seem to have had their origin in the decomposition of spheroidal nodules of troilite. Note also the cylindrical holes which penetrate deeply into the mass from both sides. These probably began with the decomposition of rod-like masses of troilite. In addition to these holes and pits the surface of the mass is indented with small shallow depressions which also seem to be a feature of the decomposition of the iron.

A fractured face shows Willamette to be remarkable for its coarse granular texture, the grains being bounded by almost definite planes suggesting crystals. A polished and etched surface shows rather broad Widmanstätten lines. Chemical analysis shows that the meteorite contains about 91.55 per cent iron, 8.09 per cent nickel and a small amount of cobalt, phosphorus and sulphur.

CANYON DIABLO.

(*Siderite.*)

Canyon Diablo is a siderite which is popularly famous chiefly from the fact that it contains diamonds. This gem stone has been definitely proven to occur in only two meteorites, the other being a Russian fall, although many masses are known to contain carbon in the form of a soft

black powder. The discovery of diamonds in Canyon Diablo was made in 1891 by Professor G. A. Kœnig of Philadelphia and was afterward confirmed by Dr. George F. Kunz of New York, Professor Huntington of Harvard University, Professor Moissan of Paris and other investigators. In 1905 Moissan dissolved a fragment of Canyon Diablo weighing

CANYON DIABLO

Weight, 1087 pounds. Diamonds have been found in specimens of this fall.

several pounds and obtained not only recognizable crystals of the diamond, but also crystals of a mineral corresponding exactly in composition to the extremely hard artificial silicide of carbon (CSi_2) known as carborundum. This new mineral has been named moissanite, and this is the first time that it has been found in nature.

Canyon Diablo was found in 1891 at and near Coon Butte, Arizona, in the vicinity of the town of Canyon Diablo. The original size of the

mass is not known, but thousands of fragments have been collected, varying in weight from a fraction of an ounce up to 1,087 pounds. More than 16 tons of this material are said to have been found within the radius of 2½ miles of Coon Butte. Coon Butte is a conical hill rising from 130 to 160 feet above the surrounding plain and containing a crater-like hollow about three-quarters of a mile in greatest diameter and probably 1,460 feet deep originally.

There is no lava of any kind in Coon Butte or in its immediate vicinity, and it is now supposed to be most probable that the "crater" was caused by an immense meteorite striking the earth at this point. The main portion of the mass has not yet been discovered, the fragments which have thus far been found being only the portions separated from the original mass during its passage through the atmosphere and at the time of its impact with the earth.

Two fragments of Canyon Diablo are in the Foyer collection, one of which weighs 1,087 pounds and is the largest piece which has been discovered. It was described and figured by Professor Huntington in the Proceedings of the American Academy of Arts and Sciences, Boston, for 1894. A slice of the meteorite in which a diamond was found is in the general Museum collection and is figured on page 15.

A polished and etched section shows strong Widmannstätten lines which are comparatively broad and somewhat discontinuous. The meteorite consists of 91.26 per cent iron and 8.25 per cent nickel and cobalt, with small quantities of copper, platinum, iridium, phosphorus, sulphur, carbon and silicon. Nodules of troilite are abundant in some parts of the masses. Through decomposition and erosion these nodules have given rise to deep holes in the iron.

TUCSON.[1]

(Siderite.)

The Tucson meteorite, which is also known as the "Signet" or the

[1] This specimen is a reproduction in cast iron of the famous Tucson meteorite, the original of which is in the National Museum at Washington. The model from which this reproduction has been prepared was presented to the American Museum by the Smithsonian Institution. The original weighs 1,400 pounds, and this cast has the same weight.

"Ring" on account of its peculiar shape, was found in the Santa Catarina Mountains about thirty miles northwest of the city of Tucson, Arizona, and its existence was known to the Spaniards for at least two hundred years before the region became part of the United States. Tradition, indeed, relates that this and many other fragments fell in a single meteoritic shower about the middle of the seventeenth century. The attention of Americans was first drawn to this and its mate, the Carleton meteorite,

TUCSON, OR "SIGNET."
Weight, 1400 pounds. A cast in iron.

in 1851 by Professor John L. Leconte, who described them as being in use by the blacksmiths of the town as anvils. In 1863 Signet was taken to San Francisco and thence transported by way of the Isthmus of Panama to the Smithsonian Institution at Washington. Carleton, weighing 632 pounds, had been removed to San Francisco the preceding year and was afterwards deposited in the hall of the Pioneers' Society in that city.

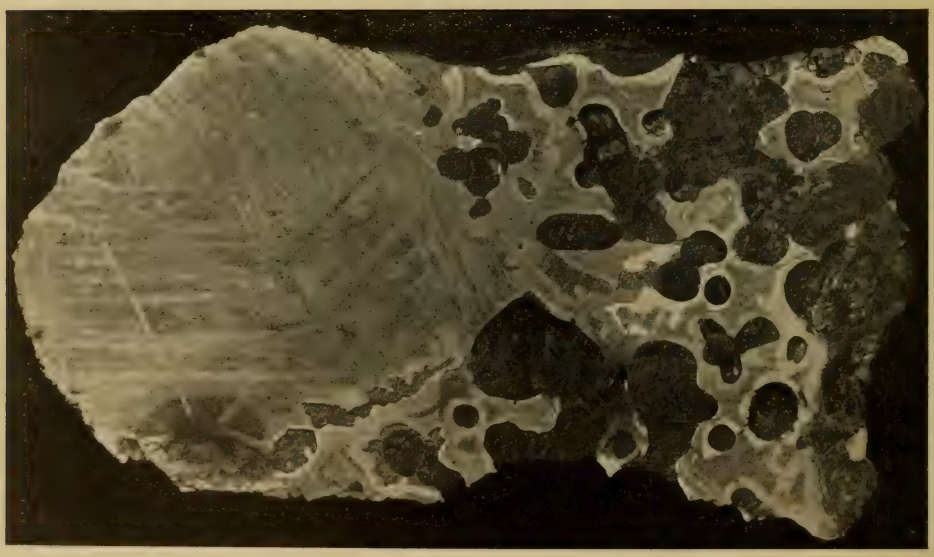
Tucson is classed as a siderite, but its average composition shows the

presence of from 8 to 10 per cent of stony matter included in the nickel-iron, and the proportions of the mineral constituents vary considerably in different parts of the mass. The nickel-iron is an alloy consisting of 89.89 per cent iron, 9.58 per cent nickel, 0.49 per cent cobalt and 0.04 per cent. copper, while the stony matter consists of olivine, carrying an unusual quantity of lime and associated with noteworthy quantities of schreibersite and chromite.

BRENHAM.

(*Siderolite.*)

Brenham is classed as a siderolite, but some of its fragments are entirely of nickel-iron. The etched section shown in the Foyer illustrates clearly the peculiar texture of the mass. The metallic portions consist



BRENHAM.
Siderite (left) and Siderolite (right) in the same piece.

of about 88 per cent. iron, 10 per cent. nickel and 2 per cent. other substances. The dark green and glassy portions are crystals of olivine, which break out from the iron almost entire.

The Brenham meteorite was found in the year 1886 scattered in many pieces on the prairie in Brenham Township, Kiowa County, Kansas, over an area more than a mile in length. The fragments were hardly covered by the original prairie soil, and several of them were projecting through the sod. Nearly all were found by being struck by mowing machines, plows or other farm implements. The occurrence of heavy "rocks" in a region where stones of any kind are a great rarity was a source of surprise to the ranchmen and led finally to the discovery that they were meteoritic in origin.

About thirty fragments of the meteorite have been found, several of which were used for many purposes about the ranches and had a rather prosaic history before their value was learned. The smaller but heavier (75-pound) mass here exhibited was used for years to hold down a cellar door or the cover of a rain barrel, while the larger but lighter (52.5-pound) mass served as a weight on a hay-stack. It is probable that the meteorite of which these are fragments burst soon after reaching the earth's atmosphere. The total weight of all the fragments of Brenham which have been found is about 2,000 pounds; the largest piece known weighs 466 pounds, the smallest an ounce or two.

Other specimens of this meteorite may be seen in the Morgan Hall of Mineralogy on the Fourth Floor.

FOREST CITY.

(Aërolite.)

On Friday, May 2, 1890, at 5:15 P. M., a brilliant ball of fire shot across the sky from west to east in northern Iowa, its flight being accompanied by a noise likened to that of a heavy cannonading, or of thunder, and by scintillations like those of fireworks. The meteoric light was dazzling even in the full daylight prevailing at the time and the noises, which were due to explosions, were heard throughout a district 200 miles in diameter. This meteor was the Forest City meteorite.

The meteorite burst when it was about 11 miles northeast of Forest City, Winnebago County, whence its name, and most of the fragments were scattered over an area about one mile wide and about two miles

long. More than a thousand fragments of this meteorite have been found, most of which weigh from $\frac{1}{20}$ of an ounce to 20 ounces, but a few weigh several pounds. Each is a perfect little meteorite. The largest of the group, which is exhibited here in the Foyer collection, weighs about 75 pounds. The black glassy crust over the surface of all the masses shows that the meteorite exploded early enough in its atmospheric flight for even the smallest fragments to become superficially fused by friction with the air. The fragments show a "primary" and

FOREST CITY.
Shows crust on large and small pieces.

a "secondary" crust, the former formed before and the latter after the bursting of the original mass.

Forest City consists essentially of feldspar, enstatite (a member of the orthorhombic-pyroxene group of minerals), graphite, troilite and nickel-iron. The iron is present in small particles disseminated through the masses and in definite lines suggesting the Widmanstätten figures of a siderite.

The approximate mineral composition of Forest City is

Nickel-iron	19.4%
Troilite	6.2%
Silicates (feldspar, enstatite, etc.)	74.4%

The nickel-iron is an alloy consisting of

Iron	92.7%
Nickel	6.1%
Cobalt	0.7%

The specific gravity of the mass is 3.8. Some chromite is present, but not as much in proportion as is found in the Long Island, Kansas, meteorite.

Some of the smaller individuals of this fall may be seen in the general Museum collection on exhibition in the Morgan Hall of mineralogy (No. 404 of the fourth floor).

LONG ISLAND (KANSAS).

(Aërolite.)

Long Island is the largest stone meteorite known, the fragments which have been recovered aggregating more then 1,325 pounds in weight. The pieces here exhibited weigh together 86 pounds, the largest weighing 32½ pounds. Some of them show the original external surface of the meteorite, but most of them show only fractures. The meteorite was found in more than 3,000 pieces scattered over a gourd-shaped area only 15 or 20 feet long and 6 feet wide in the northwestern corner of Phillips County, Kansas, near the town of Long Island, whence its name. The small area of distribution shows that the mass burst just as it struck the ground, or that it was broken by impact. The late time of bursting is also indicated by the lack of secondary crust on the pieces.

Stony matter makes up about 80 per cent by weight of Long Island, the remainder having originally been nickel-iron and troilite, now partly changed to limonite through rusting. On the polished surfaces of some of the fragments in the case the nickel-iron may be seen as small shining dots. The stony matter consists essentially of the minerals bronzite (one of the orthorhombic pyroxenes), olivine and chromite

and bears a close and interesting resemblance to the terrestrial basaltic igneous rock peridotite. The content of chromite (9 per cent of the whole) is remarkable and is the highest yet reported in meteorites.

Long Island presents a feature heretofore unknown in meteorites. Certain of the planes of fracture show striated surfaces with grooving and polishing (slickensides) due to the parts grinding together in their

LONG ISLAND.

Slickensided surface showing movement in the mass before it fell.

flight through space before the mass reached our atmosphere. Two of the pieces in this case show such slickensided surfaces and one of them is illustrated on this page.

Other fine specimens of Long Island may be seen in the general meteorite collection on the fourth floor of the Museum (Hall No. 404).

SELMA

Weight, 306 pounds. Front or "Brustseite."

SELMA.

(*Aërolite.*)

The Selma meteorite is believed to have fallen at about 9 o'clock, P. M., July 20, 1898, but it was not found until March, 1906. The meteor of July 20, 1898, seems to have traveled in a direction somewhat west of north, and its flight is said to have been accompanied by a heavy rumbling noise and a "trail of fire ten or twelve feet long." The meteorite was found about two miles north-northwest of Selma, Alabama, near the road to Summerfield, and it takes its name from the nearest town, as is the rule with meteoritic falls.

Selma weighs 306 pounds in its present condition, and it is probable that its original weight was about four pounds more, one or more small fragments having been lost from the mass. It is one of the ten largest aërolites ever found, and is the fourth largest aërolite that has fallen in the United States. The others having been broken up, this is probably the largest entire stone meteorite in the country at the present time. Its dimensions are: length, as it rests on its pedestal, 20½ inches; width, 20 inches; height, 14 inches.

In shape Selma is roughly polyhedral without pronounced orientation features, but it is probable that the upper side, as the specimen now lies, was the "brustseite" or front during the flight of the mass through the atmosphere. This side is bluntly pyramidal in shape. The original glassy crust of the meteorite has been mostly decomposed and washed away so that the characteristic thumb-marks, or piëzoglyphs, have been partly obscured. These peculiar markings may be seen on the front of the meteorite and in the illustration on page 37. The mass is deeply penetrated by cracks on both sides, and the position and character of the fissures indicate that they were caused by unequal heating during flight through the atmosphere, the tension produced not being enough, however, to cause complete fracture.

During the years while the meteorite lay buried in the ground alteration due to decomposition advanced considerably. A cut and polished fragment shows the unaltered stone to have a dark brownish-gray color and to be made up of spheroidal "chondrules" firmly imbedded in a matrix of similar matter. The largest chondrules observed are one eighth inch across, but these are extremely rare and most of the

particles have less than half this diameter. Close examination with a strong magnifying glass enables one to see minute grains of iron scattered through the mass. The stony portion of this meteorite consists of olivine, enstatite and a monoclinic pyroxene, while the iron contains a little troilite. The specific gravity is 3.42.

The American Museum Journal

EDMUND OTIS HOVEY, *Editor*

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AMERICAN MUSEUM OF NATURAL HISTORY

The Malaria Mosquito

By B. E. DAHLGREN, D. M. D.

Assistant Curator of Invertebrate Zoölogy

GUIDE LEAFLET NO. 27

APRIL, 1908

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FIG. 1. THE MALARIA MOSQUITO (*Anopheles maculipennis* Meigen). MALE.

From a photograph of the model (× 75) in the American Museum. Magnification of figure about 9 diameters.

The Malaria Mosquito

A GUIDE LEAFLET

EXPLANATORY OF A SERIES OF MODELS

IN THE

AMERICAN MUSEUM OF NATURAL HISTORY

By B. E. DAHLGREN, D. M. D.

ASSISTANT CURATOR OF INVERTEBRATE ZOOLOGY

NO. 27

OF THE

GUIDE LEAFLET SERIES

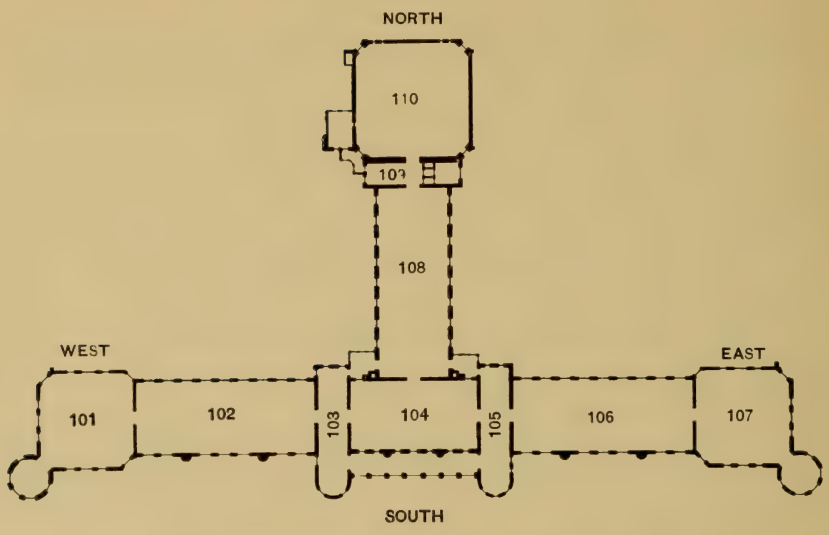
OF THE

AMERICAN MUSEUM OF NATURAL HISTORY

EDMUND OTIS HOVEY, EDITOR

New York. Published by the Museum. April, 1908

FIRST FLOOR



SKETCH PLAN OF FLOOR.

The series of enlarged models (× 75 diameters) the construction of which led to the studies upon which this Leaflet is based in part were prepared at the Museum by and under the direction of Dr. B. E. Dahlgren, the author of the Leaflet. The models have been placed on exhibition in the middle of the Synoptic Hall, No. 107, at the east end of the ground floor of the building.

EDITOR.

TABLE OF CONTENTS.

	PAGE
Introduction	5
The Malaria Mosquito:	
The Egg	10
The Larva	12
The Pupa	18
The Adult	21
The Internal Organs	32
Malaria	34
Yellow Fever	40
Insects as Carriers of Disease	43
Mosquito Extermination	45
Literature on Mosquitoes	47

THE MALARIA MOSQUITO.[1]

By B. E. Dahlgren, D. M. D.

Assistant Curator of Invertebrate Zoölogy.

Introduction.

THE word "mosquito," supposedly of West Indian origin, is the Spanish diminutive of "mosca," a fly, and the name is correctly applied, since mosquitoes belong to the order of two-winged insects, or true flies, Diptera. They constitute the family Culicidæ, of which some four hundred fifty species are known at the present time.

Since the discovery of the agency of mosquitoes in the spreading of malaria and yellow fever, they have received a great deal of attention, and new species are constantly being found. The great majority are tropical, but their range of distribution is nearly universal, extending from the Equator northward and southward, over the temperate zones into the arctic and antarctic regions. About forty species have been described from the neighborhood of New York.

Distribution

Though mosquitoes occur in general in low and swampy districts, they are also recorded from high altitudes, and Stephens and Christopher in a Report to the Malaria Commission of the Royal Society, state that they are troublesome in the Himalayas at a height of 13,000 feet. A well known malarial species is recorded by them at 5,000 feet. In the United States mosquitoes are numerous not only along the coasts, in the low-lying regions of the South and on the plains and prairies, but also in many places in the woods of the Adirondacks and Rocky Mountains. In Alaska, on the coast of Greenland and on the tundras of the North where other insects are few, they at times constitute a severe scourge, and Arctic explorers relate accounts of mosquitoes on the snow which make a New Jersey swamp seem a desirable resort. Nansen, quoted by Theobald, states that at high latitudes, they literally covered the hands of the voyagers like "rough woolen gloves." In ancient Greece, and in Asia Minor, entire cities[2] were abandoned by their inhabitants, who were

[1] Guide Leaflet No. 27 of the American Museum Series.

[2] Mionte in Ionia, Pergamo in Asia. Howard, Mosquitoes, p. 40.

obliged to flee from the intolerable swarms of gnats that descended upon them.

Dissemination

Certain artificial agents seem to play some rôle in the dissemination of mosquitoes. Railway trains are said to be responsible for the distribution of the insects, and tracts which have been practically free from the pest are thought to have been invaded as the railroad lines opened up the country. One species occurring in Australia is supposed to have been "imported from Europe in the watertanks of some old sailing vessel."[1] At the port of New York a

FIG. 2. THE DISTRIBUTION OF ANOPHELES.
After Theobald.

dozen foreign species have been observed on ships in quarantine. Mosquitoes are also carried by the wind. The fact that hosts of adult mosquitoes are to be found in localities where not a single larva of the species may be discovered, led Professor John B. Smith, of New Jersey, to investigate the question of migration of mosquitoes, and he has learned that large swarms of them may, with a moderate wind, fly or drift thirty or forty miles. Shore mosquitoes are found far inland, and, on the other hand, swarms have been seen many miles out at sea.

[1] Skuse, as cited by Theobald, Culicidæ of the World, Vol. 1, p. 82.

The number of mosquitoes in a large swarm is beyond comprehension, and accounts of "immense clouds filling the air"—"like a column of smoke," or "like a dense wall, miles in length," are by no means infrequent. L. O. Howard,[1] Chief of the Bureau of Entomology at Washington, describes a swarm observed in Texas, the main body of which was three miles wide, and which required nearly five days to pass a given point. Such migrations of mosquitoes, though they are usually on a smaller scale, account for the sudden appearance of the insects in areas from which they were previously absent, and their equally sudden disappearance.

Mosquito Swarms

As a rule, mosquitoes are frail insects and weak flyers. In rain or winds they hastily seek shelter. The Malaria Mosquito (*Anopheles*) avoids places where draughts exist, and seldom flies more than a few hundred yards. An Indian species of the genus is known which flies a quarter of a mile, but rarely as far as half a mile. The Malaria Mosquito as a rule, spends its entire life in the immediate neighborhood of human dwellings.

Habits

Mosquitoes are most active at early dawn and after sunset. They seem in general to avoid strong light and to prefer dark colors. The hours of daylight are spent by most species hiding in some secluded spot in a tuft of grass or a bush, while the Malaria Mosquito finds some dark corner indoors, where it passes the day. There are, however, some notable exceptions to this general rule. The Yellow Fever Mosquito flies at almost any time of day, except noon, and several tropical species resemble it in this respect.[2]

In the autumn all the males die, while the fecundated females seek winter quarters. The Malaria Mosquito, which is essentially a house mosquito, may be found hibernating in dark corners in cellars, sheds or attics. The strictly out-of-door species find winter quarters in the woods or in the fields. In the arctic regions mosquitoes find suitable hibernating places under moss. Large numbers of the insects undoubtedly perish during severe winters, but, under ordinary conditions, enough mature females survive to furnish locally the first brood of the following season. A warm day in early spring brings the insects out of their stupor; on a sunny day in mid-winter

Hibernation

[1] Mosquitoes, How they live, etc., p. 22. See also Theobald's Monograph of the Culicidæ of the World for several interesting accounts.

[2] One of the local species of Anopheles (*A. crucians*) is a "daylight mosquito."

they may occasionally be seen on the snow. In tropical countries the dry season is the period of inactivity for the mosquitoes.

The food of mosquitoes consists ordinarily of the nectar and juices of plants and fruits. This is always true of the males, whose mouth-parts are not at all adapted for stinging. In certain species neither sex seems to have any taste for blood, while on the contrary, it is well known that mosquitoes living far in the woods, in the swamps, or in the Arctics where their chances of obtaining a meal of blood may be almost infinitesimal, nevertheless, will seize greedily upon the opportunity when it offers. It has been thought that a full meal of human blood is necessary for the female Malaria Mosquito, in order that she may lay her eggs, but this is certainly questionable. Theobald maintains that, in England at least, the Malaria Mosquito seldom sucks blood. Mosquitoes of sanguinary taste by no means confine themselves to human, or even mammalian blood, they suck with eagerness the blood of birds and reptiles whose skin they may be able to pierce. They have frequently been observed feeding upon other insects and on caterpillars. Howard asserts that they will attack small fish when these come to the surface of the water. In captivity, mosquitoes are fed with success on slices of banana or apple. They require water, but may exist for months without any food whatever. On the other hand, they may feed as often as they have opportunity, though several hours are required for the digestion of a full meal.

Food

The average length of life of female mosquitoes is not less than a month or two, but hibernating females must live at least six or even eight months. The life of the males is much shorter, and may not exceed a few days in duration. The point is difficult to determine, since in captivity death may be the result of various artificial conditions. To compensate for the shortness of life of the males, they greatly outnumber the females. In several broods hatched in aquaria in the Museum the ratio of males to females was eight or nine to one. Since a recently hatched mosquito becomes full grown in two or three days, and it may lay its first batch of eggs within a week, there may be as many as a dozen or more generations in the course of a year, in favorable localities, but seasonal conditions necessarily exert great influence on the number of broods. In dry climates breeding is confined to the rainy season, in humid tropical climates it may extend throughout the greater part of the year, while in

Length of Life

Courtesy of J. B. Smith.

FIG. 3. MOSQUITO-BREEDING POOL ON CAPE MAY.

This pool, with an area of 1,894 square feet, had a population of ten and a half millions of mosquito larvæ (*Anopheles crucians* Wied), the sixth brood of the season. (Smith, Report on Mosquitoes, p. 403.)

the Arctics it must naturally be very short. In temperate climates the first brood generally appears in April or May, while in October and November the fecundated females seek their winter quarters.

Breeding places

The female mosquito lays its eggs, from fifty to two hundred in number, on the surface of any convenient quiet body of water. Certain mosquitoes prefer to lay their eggs on brackish water. Thus, the females of *Culex cantator* and *C. sollicitans*, both salt-marsh mosquitoes, which were found by Professor Smith in inland swarms, were observed returning to the shore with developed ovaries, and this seemed to him "in the nature of a return migration for oviposition."

Though mosquitoes of the various species may differ widely in many minor details such as size, color, form of scales and markings on the body, wings and legs, in all essential respects of structure and life-history they are similar. The following description, however, applies particularly to the local Malaria Mosquito (*Anopheles maculipennis* Meigen), which is represented by a series of large-scale (× 75 diameters) models in the Museum. Other mosquitoes are treated of incidentally, as they differ from the Malaria Mosquito in some important respect.

The Malaria Mosquito.

The Egg.

Anopheles Eggs

Mosquito eggs are minute bodies, measuring only one half to one millimeter (one fiftieth to one twenty-fifth of an inch) in length. They are generally ovoid in form, but the particular configuration of their covering, or shell, of chitin varies considerably in different species. The egg of Anopheles (Fig. 4) is boat-shaped with one end somewhat pointed, the other rounded. The lower surface, the bottom of the boat, is strongly convex and reticulated, the upper surface, the deck, is more flattened. The egg is provided on the sides with corrugated air chambers which serve as floats. When recently laid the eggs appear almost white in color, but they darken rapidly and in a few hours become nearly black.

Arrangement of Eggs

In the process of deposition the eggs of the Common Mosquito unite to form raft-like masses, which are known as "egg-boats" or "floats" (Fig. 5). The eggs of Anopheles, however, are deposited separately, but they may be found arranged in various patterns on the surface of the water, forming

star-shaped groups or adhering side by side to make miniature pontoon-bridges (Fig. 6). The eggs of certain species are never laid on water, but on mud, perhaps at the edges of pools, and are said not to develop at all, unless they be left dry for at least twenty-four hours.

Resistance

The eggs of some mosquitoes will survive drying for two or three months, while those of others with a thinner chitinous shell, easily perish if the mud or water of the pool in which they have been laid dries up. Ordinarily, mosquito eggs are not resistant to cold and will not survive freezing, though those of some species are actually known to hibernate.

SIDE VIEW

AIR CHAMBERS WHICH ACT AS FLOATS

SURFACE VIEW

FROM NUTTAL AND SHIPLEY

FIG. 4. THE EGG OF THE MALARIA MOSQUITO.
Magnification about 60 diameters.

FIG. 5. "EGG-RAFT" OR EGG-BOAT OF THE COMMON HOUSE MOSQUITO (*Culex pupiens* Linn.).
Magnification 12 diameters.

When the eggs are ready to hatch, in about two to four days after they are laid, a small cap-like portion of the envelope bursts off at the rounded end of the egg and the larva escapes.

Hatching

In the "egg-boats" of Culex the rounded end of each egg is directed

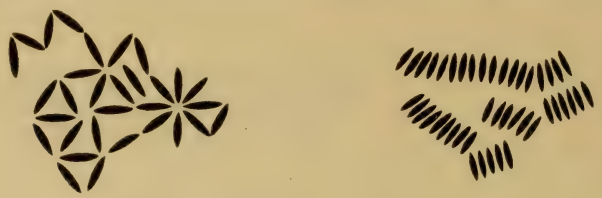


FIG. 6. EGGS OF THE MALARIA MOSQUITO.
Characteristic arrangements on the surface of the water. Magnification 7 diameters.

downward and the larvæ escape into the water from the lower surface of the float (Fig. 7).

The Larva.

Mosquito larvæ are popularly known as "wigglers" or "wrigglers," because of their peculiar motions in swimming. At the time of hatching, the larvæ of the Malaria Mosquito are minute. The transparent body is cylindrical and is exceeded in diameter by the small, brownish, rounded head. As soon as freed from the egg the larva begins to feed. It grows rapidly, and, if the food supply is abundant and the temperature of the water is not too low, it attains its full size in a few days. The body is divided into the head, the thorax and the cylindrical abdomen of nine rings or segments (Fig. 8). In a newly

FIG. 7. MOSQUITO LARVÆ (*Culex pipiens* Linn.) HATCHING FROM AN "EGG-RAFT".

The escaping larvæ are carrying on their heads the cap-like lower ends of the egg shells. These caps may be seen attached, like hinged lids, to some of the eggs of the raft, and this is the usual condition. The egg-raft was in this case disturbed, and the instant and simultaneous hatching of the larvæ occurred with such sudden violence that the lids were carried away on the larvæ heads. Magnification about 12 diameters.

Divisions of the body

FIG. 8. THE LARVA OF THE MALARIA MOSQUITO (*Anopheles maculipennis* Meigen).

Photograph of the model (× 75) in the American Museum. Magnification of the figure about 20 diameters.

hatched larva the latter regions can hardly be distinguished from each other, but as the larva grows the three fused segments of which the thorax consists become enlarged and flattened. Legs are absent, but both thorax and abdomen bear a great number of symmetrically placed pairs of branched feather-like hairs, arranged in a manner characteristic of the species. These hairs project laterally and aid in maintaining equilibrium, but they undoubtedly serve other purposes too, being also organs of touch and possibly of respiration. Similar, but smaller, hairs are found on the back of the head, and many very small, simpler hairs are distributed over the whole body, particularly along the back and sides. On the back of the abdomen are five or six pairs of dark-brown palmate structures, which float on the surface of the water, when the larva is at rest, and aid in maintaining the horizontal position of the body which is characteristic of larvæ of the genus Anopheles.

Appendages

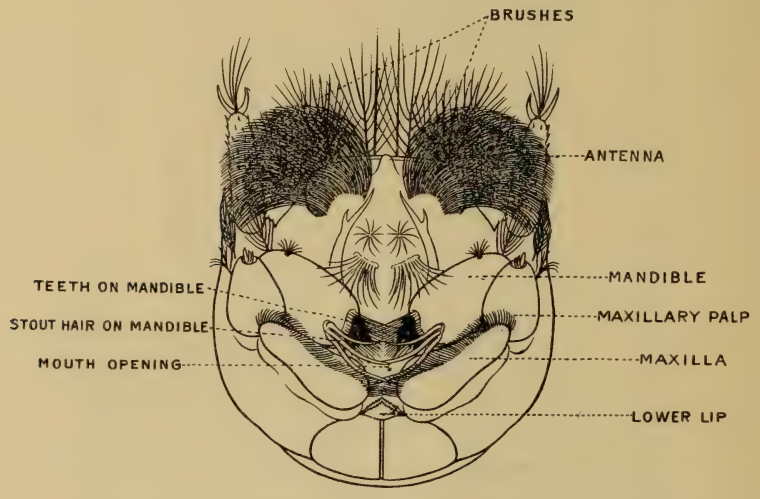


FIG. 9. HEAD OF ANOPHELES LARVA, SHOWING MOUTH-PARTS.

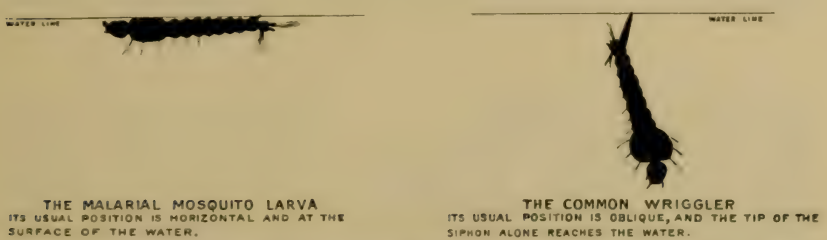
Ventral view. Magnification 45 diameters.

The next to the last segment bears on its upper side the short "siphon," which reaches the surface of the water, when the larva floats in its usual position. In the siphon are the openings of the two main tracheæ, or respiratory tubes. The larva is strictly air-breathing and does not normally remain away from the surface of the water, except

when disturbed, and then only for a short time. That the larva must have air in order to live makes possible its destruction by means of a film of oil spread on the surface of the water. The oil, acting mechanically, closes the openings in the respiratory siphon and causes the larvæ to die from suffocation. If oil is poured on the surface of an aquarium in which the larvæ are kept, they may be seen, after an instant's contact with the film, in frantic contortions, as they strive to free themselves from the oil, lashing the end of the abdomen about and even desperately biting the tip of the siphon.

Effect of Oil

The last segment of the abdomen has terminally two pairs of bristles and four elongated sac-like appendages with very thin walls, the "blood-gills." On its under side it bears a large fan-like arrangement of branched hairs which seems to serve as a keel or rudder.



THE MALARIAL MOSQUITO LARVA
ITS USUAL POSITION IS HORIZONTAL AND AT THE SURFACE OF THE WATER.

THE COMMON WRIGGLER
ITS USUAL POSITION IS OBLIQUE, AND THE TIP OF THE SIPHON ALONE REACHES THE WATER.

FIG. 10. CHARACTERISTIC POSITION OF LARVÆ OF MALARIA AND COMMON MOSQUITO.

The head of the mature larva is large and rounded and is brown in color. It is united to the thorax by a membranous neck which allows considerable freedom of movement. Its upper surface is characteristically marked by dark-brown spots and bears rows of branched hairs. On the sides of the head are the antennæ extending forward, and behind these are the eyes. In front, on the under side and over-hung by the elongated anterior portion of the head, is the mouth, which is surrounded by a formidable armature (Fig. 9). Overhanging the mouth-parts and at the most anterior part of the head are two moustache-like brushes. Below these and behind them are two mandibles which move laterally and bear strong spine-like teeth for crushing food. On either side of the mandibles project the cylindrical maxillary palps, and below the mandibles are the flattened maxillæ beset with fine hairs. Below all of these mouth-parts is the small triangular so-called "lower lip."

Head of larva

1

2

FIG. 11. TYPICAL BREEDING PLACES.

1. A suburban scene with a neglected gutter (from J. B. Smith, Report on Mosquitoes). 2. A pool on an "unimproved" lot on Broadway, New York City.

Anopheles larvæ exhibit a curious habit of suddenly twisting the head. The peculiar, almost audible "snap" or "click" with which the sudden turning is accomplished is very characteristic. On this account the name "head-turners" has been proposed for them.[1]

The larva feeds with its head turned so that the lower side, which bears the mouth, is directed upward. The moustache-like brushes, by rapidly sweeping the under side of the surface-film of the water, set up a current which carries food into the mouth. Small particles which become entangled in the brushes are combed out by stout curved hairs, three or four of which are borne on each mandible, the brushes bending back into the mouth for this purpose from time to time.

Manner of feeding

The food of the larva consists of the microscopic animals and plants which abound at the surface of the water. Little discrimination seems to be exercised in the choice of food, anything which is carried into the mouth, even sand grains, being sometimes voraciously swallowed. The intestine, which is practically a straight tube, may usually be seen in the rather transparent living animal, colored dark by its contents. The entire larva often appears green from ingested algæ.

Food of Larva

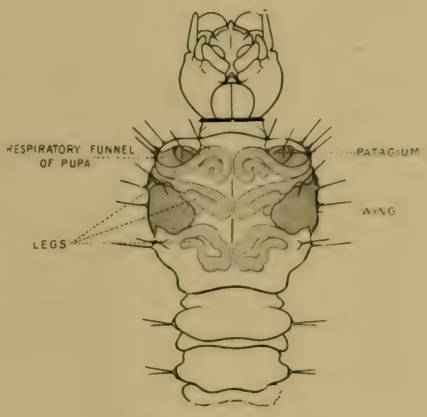


FIG. 12. MATURE LARVA OF ANOPHELES.

Ventral surface. The figure shows clearly the formation of the thorax of the future insect within the larval thorax. Magnification, 13 diameters.

The Malaria Mosquito larva may be readily distinguished from the larva of the Culex Mosquito by the shortness of its siphon and its horizontal position in the water. The common "wrigglers" have elongated siphons and are always found hanging obliquely, or even vertically, head downward, the tip of the siphon only reaching the surface (Fig. 10).

The larvæ of certain mosquitoes are known to hibernate, and may remain throughout the winter frozen in the ice, coming to life when the ice melts in the spring. Professor Smith

Hibernation

[1] Minot, C. S. Notes on Anopheles. Boston Soc. Med. Sci. 1901.

gives an account of having repeatedly obtained certain mosquito larvæ in large quantities, by thawing out ice which had formed in the leaves of the pitcher plant (*Sarracenia*).[1] When pools in which the wrigglers live dry out, the larvæ usually perish in a short time. They are most likely to be found in small and undisturbed bodies of water, such as accumulate in little hollows between tufts of grass, in meadows, or in ditches where there is no perceptible flow (Fig. 11). Where there is any current in the water the larvæ are easily swept away, and those that occur in moving water are always found along the edges of the stream, where they are out of reach of the current. Cat-tail swamps are said to be practically free from mosquito larvæ, probably because of the usual presence in them of small fish. Such places as neglected tin cans or broken bottles, rain barrels, cisterns and deep wells may be swarming with larvæ. Dr. Howard mentions a case where the census of the inhabitants of a rain barrel was taken. In one month it yielded 36,369 mosquito eggs, larvæ and pupæ.[2]

Number

The duration of the larval stage is usually from seven to fourteen days. During this time the various parts of the adult insect are in process of formation under the larval skin (Fig. 12). In older larvæ the adult eye, for instance, may be seen as a crescentic dark mass lying near the larval eye. The legs and wings of the future "fly" may be seen forming within the larval thorax. The formation of adult structures is accompanied by destructive changes in the strictly larval internal organs and tissue. In due time, when this process has proceeded far enough, a T-shaped split occurs in the back of the larval skin and through this the insect emerges as a pupa.

The Pupa.

The pupa which escapes from the larval skin forms the next stage in the development of the insect (Figs. 13 and 14). It too is aquatic in habit and ordinarily leads a brief and comparatively quiet life. It does not feed. When at rest, it floats at the surface of the water, breathing through a pair of funnel-like tubes. It is, however, able to execute very rapid, though jerky, movements and

Habits of Pupa

[1] John B. Smith, N. J. State Agr. Exp. Station. Report on Mosquitoes, p. 346. 1905.

[2] L. O. Howard, Mosquitoes, p. 44.

darts downward instantly when disturbed. If confined in a glass vessel, it may be seen on such occasions to strike the bottom repeatedly, returning to the surface of the water by its own buoyancy as soon as its movements cease. The downward swimming is accomplished by a few vigorous strokes of the strongly curved abdomen, which bears at its tip a pair of "paddles," or "flippers," and is the only freely movable part of the body.

FIG. 13. THE PUPA OF THE MALARIA MOSQUITO. FEMALE.

Photograph of the model (× 75) in the American Museum. Magnification of the figure about 15 diameters.

Structure of Pupa

Under the transparent integument of the pupa may be seen outlined the body and appendages of the developing mosquito (Fig. 15). The head is drawn up against the anterior part of the thorax, giving the pupa its characteristic hunchbacked appearance. The strongly flexed abdomen curves downward and forward under the thorax. The elongated mouth-parts, the "proboscis" of the

future fly, lie directed downward and backward in the median line, forming a "keel" just beneath the thorax. The legs are bent at the knee-joints and lie pressed against the thorax on each side, then they turn backward and terminate in S-shaped curves under the fore part of the abdomen. They are partly concealed by the wings, which hang, cramped in their wing-cases, closely pressed against the body on each side of the thorax. Arising from the anterior third of the thorax in front of the attachment of the wings, are the respiratory tubes terminating in funnel-like expansions which spread out on the surface of the water when the pupa is in the ordinary position of rest. In respect to the position of its respiratory openings, the pupa differs decidedly from its

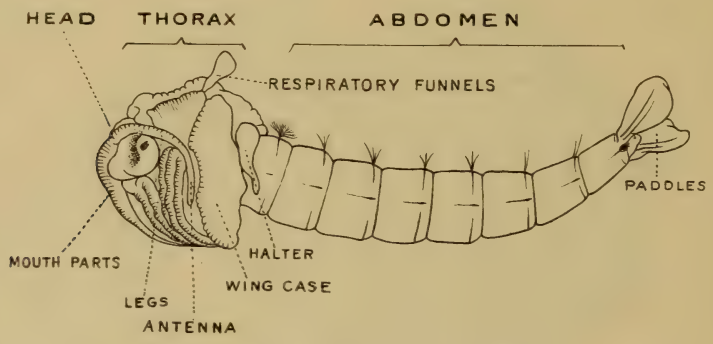


FIG. 14. THE YOUNG PUPA OF ANOPHELES.

The abdomen of the emerging pupa is straight or with a slight upward curve. The strong downward abdominal flexure of the older pupa becomes established a few hours later. Magnification 12 diameters.

predecessor, the larva, which has its siphon near the end of the abdomen. Like the larva, it is easily destroyed by anything which interferes with its free access to the air. Curving backward from the head, above the legs and in front of the wings, are the two antennæ. Below the origin of the antennæ lie the two palps, with sharply S-shaped flexures.

Duration of Pupal Life

The duration of the pupal stage is usually from two to four days, but it may, under unfavorable conditions of temperature, be prolonged to weeks. On the other hand, the threatening danger of a drought or the presence of a disagreeable substance in the water, such as the phinotas oil used for destroying mosquitoes, may very much hasten the emergence of the fly.

The pupa represents that period in the metamorphosis of the insect

during which the internal changes begun in the larva, which are to result in the formation of the adult mosquito, are continued and completed. Under the pupa skin a new integument is secreted which becomes the final external covering of the fly. Its appendages, hairs and scales may be seen fully developed in late pupal stages like the one represented in the model as shown in Fig. 13.

Formation of the Adult

When the formation of the mosquito fly is complete, the pupa skin bursts along the middle of the back and the adult extricates itself from its floating case. At this "critical period," large numbers of mos-

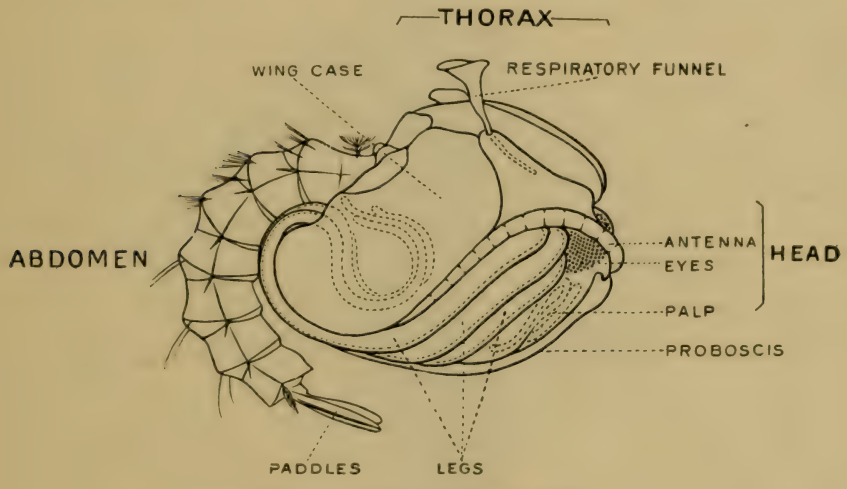


FIG. 15. THE FULL-GROWN PUPA.
Magnification about 12 diameters.

quitoes perish, because, until their legs and wings are thoroughly hardened, a slight gust of wind or a ripple of the water will upset and drown them. This makes it possible to bring about the artificial destruction of a large proportion of the insects, through the simple introduction of tidewater into mosquito-ridden marshes.

The Adult Mosquito.

The smallest of the local mosquitoes measures not more than 1.5 mm., while the largest, perhaps, the famous "Jersey mosquito" (*Psorophora ciliata*), called "Gallinippers" in the South, attains a length

Size

of 8 to 10 mm., — almost half an inch. The Malaria Mosquito is from 6 to 8 mm. long.

Body-covering

The body of the mosquito, like that of all other insects, is covered with a dense, though very thin, continuous layer of a hard substance, "chitin," secreted by the true, cellular skin, or hypodermis, which lies underneath it. The chitin not only affords protection to the body, but also gives support to the limbs and wing-veins and forms in fact an external skeleton, on the inner side of

FIG. 16. AN ANOPHELES MOSQUITO EMERGING FROM ITS PUPA CASE.

Head, thorax and abdomen are free, but the wings are not entirely freed and the long legs are still partly coiled within their pupal integument. Photograph from life, greatly enlarged.

which the muscles of the insect are attached. Wherever rigidity is required, the chitinous coat is thickened, but elsewhere it remains thin to permit movement of the body segments.

Divisions of Body

Three main regions of the body may be easily distinguished, the small rounded head with its appendages, the relatively large thorax, and the elongated abdomen (Figs. 1 and 17). The head, which is connected with the body by means of a rather slender neck,

bears the mouth-parts and special sense-organs. The thorax, which consists of three closely consolidated segments, bears the organs of locomotion, the legs, one on each segment, the wings on the middle segment and a pair of minute balancers on the third. The abdomen is distinctly segmented and consists of eight rings, but, except on the terminal segment, it bears no appendages. The almost spherical head is somewhat flattened in front.

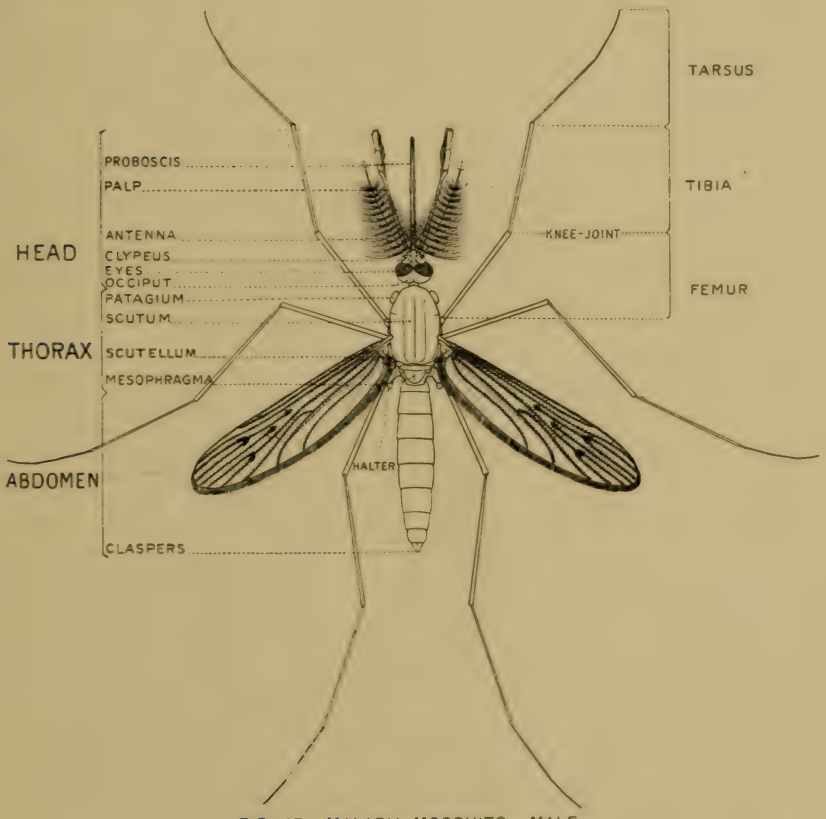


FIG. 17. MALARIA MOSQUITO. MALE.
Magnification 7 diameters.

The anterior portion of the head is occupied by two large compound eyes, each composed of several thousand simple eyes or facets, regularly arranged and so closely crowded together that their outlines appear hexagonal. In such compound eyes each separate facet receives rays of light from only a single direction, but the great number

Head

of facets distributed over a spheroidal surface makes it possible for the mosquito to see in almost every direction.

In front of the eyes are the antennæ, two slender organs, with a central jointed axis of 15 or 16 segments, each bearing a whorl of fine hairs. The antennæ are organs of hearing, and by means of them the male is able to detect the presence of the female. If the "song" of a female mosquito be imitated with a tuning fork, the antennæ of the male mosquito, which support long and exceedingly delicate whorls of hairs (Fig. 1), that respond to every vibration of the air, may be seen to bend in the direction from which the sound proceeds.[1]

Antennæ

Below the antennæ, at the very front of the head, are the mouth-parts,

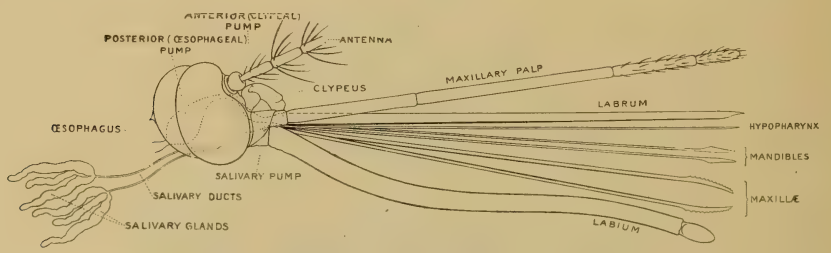


FIG. 18. HEAD OF FEMALE MALARIA MOSQUITO.

constituting the so-called "proboscis" (Fig. 17). This consists of several members. The principal one, lying above all the other mouth-parts, is the "labrum," deeply grooved along its lower side.[2] Under the labrum there is a delicate chitinous lamella, the "hypopharynx." The hypopharynx is closely applied to the labrum along its entire extent, and by closing the groove therein from below, forms therewith the tube through which the mosquito sucks up blood or other liquid food (Fig. 19). A fine tubular channel which runs along the median line of the hypopharynx serves to conduct the poison that the mosquito pours into the wound when sucking blood. Along the sides and below the tube, composed of these two mouth-parts, there are two pairs of very slender chitinous rods, expanded at the ends into lancet-like blades set with fine teeth. One pair, the "mandibles," are exceedingly delicate; the other, the "maxillæ," are stouter and have

Proboscis of Female

[1] Mayer, A. M. Researches in Acoustics. Am. Jour. Sci. and Arts. III, viii, p. 81. 1874.

[2] The "labrum" is undoubtedly a compound structure and properly is the "labrum-epipharynx."

larger teeth. These latter pairs of instruments enter the wound made by the point of the labrum, and with their saw-like blades, serve to brace the head while the "sucking-tube" is thrust forward. By a to-and-fro motion which alternates with that of the piercing tube, they are pushed into the tissues together with the tube, and their fine teeth undoubtedly also serve to lacerate the tissues in the wound and to produce an increased flow of blood at the point of the sucking-tube.

All these mouth-parts, *viz.*: the labrum, the hypopharynx, the mandibles and the maxillæ, form a very compact bundle which, when not in action, is almost entirely contained in a groove on the upper surface of the lower lip or "labium" (Fig. 19). This is attached below the base of the other mouth-parts. It is equal to them in length, but much larger than all the others taken together, and is flexible and forms a sheath which serves for their protection. Its outer surface is beset with scales. Of the whole bundle of mouth-parts only the labium and upper surface of the labrum are ordinarily visible. At the tip of the labium, two small pointed movable flaps, or "labellæ" are hinged (Figs. 18 and 26), which protect the points of all the mosquito's delicate surgical instruments, when these are not in use. The separation of these flaps exposes the points ready for instant action (Fig. 26). The female alone sucks blood. In the male the maxillæ are lacking, and the tip of the labrum is blunt and unfit for piercing.

Proboscis of Male

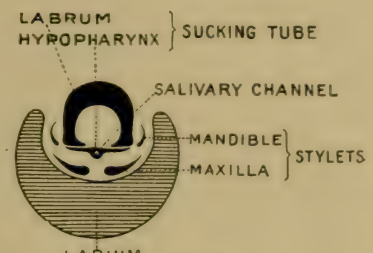


FIG. 19. CROSS SECTION OF THE PROBOSCIS.

The mouth-parts, which are represented in solid black, are those which the insect actively employs in stinging. Female.

The first, though somewhat erroneous, account of the mouth apparatus of the mosquito is contained in Swammerdam's "Bybel der Natuure" (1668) published in Holland in 1738. In 1739, the French scientist Réaumur published a description of the mosquitoes' manner of biting. His illustrations, here reproduced (Fig. 20), show well how the soft labrum is pushed away and flexed in biting, and how only the labellæ remain in contact with the stylets at the point of their entrance into the wound.

Manner of Stinging

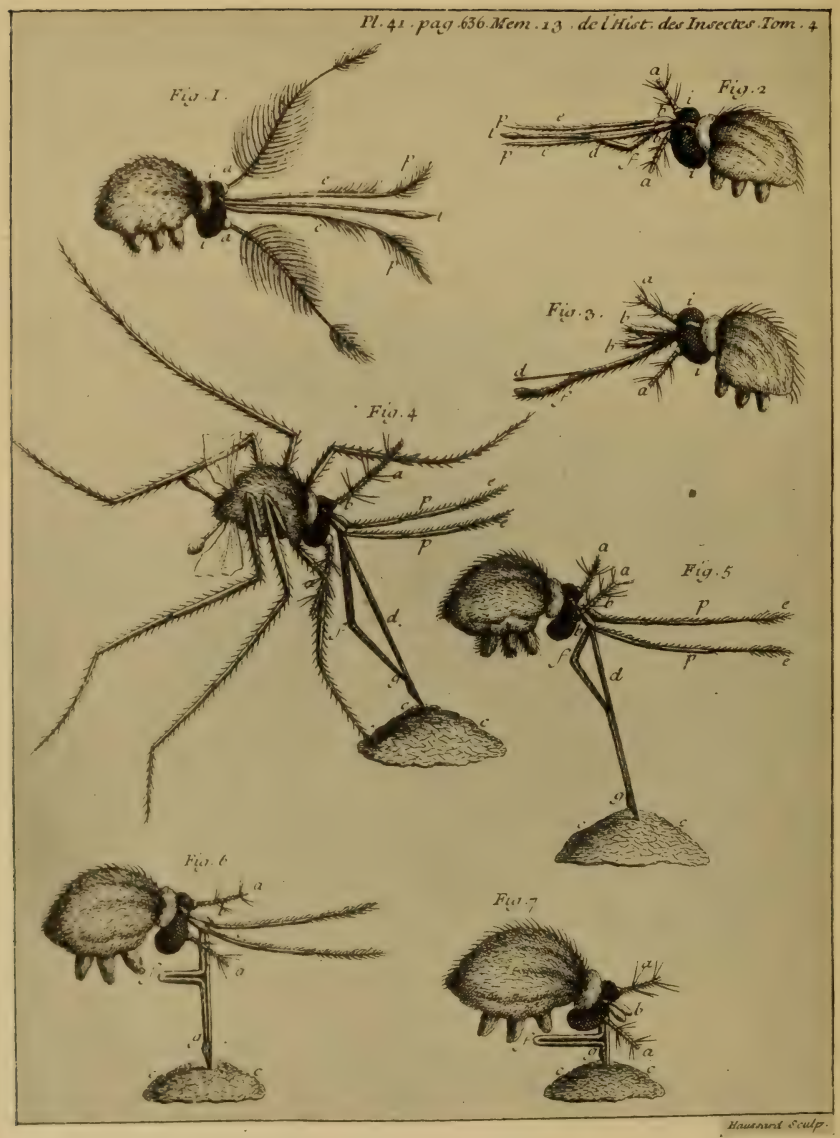


FIG. 20. HEAD AND THORAX OF THE MOSQUITO.

Fig. 1. Male. Figs. 2–7. Females, 4–7, in the act of stinging. Reproduction of a plate in Réaumur's Mémoires pour servir à l'histoire des Insects, 1739.

On either side of the proboscis there are two long pointed appendages of the maxillæ, the maxillary palps, which serve as organs of touch. In the female Malaria Mosquito they are slender and of uniform thickness; in the male the terminal segment is enlarged and bears long hairs (Figs. 21 and 22). In both sexes of the Malaria Mosquito the palps are long, equal in length to the proboscis, and covered with fine scales. In the common Culex Mosquito, the palps of the female are short (Fig. 21), not more than half the length of the

The Palps

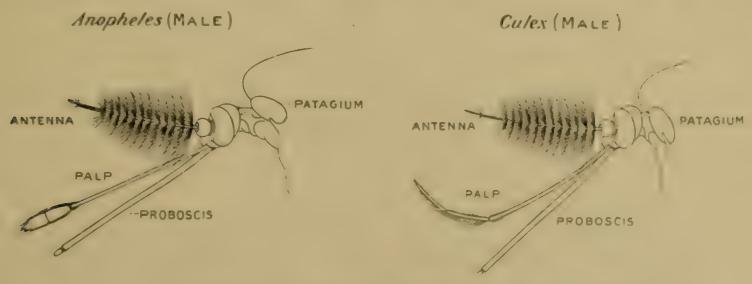


FIG. 21. THE MALARIA AND THE COMMON MOSQUITO. MALE.
Suggested by figures of Eysell, in Arch. für. Schiffs- u. Tropenhygiene.

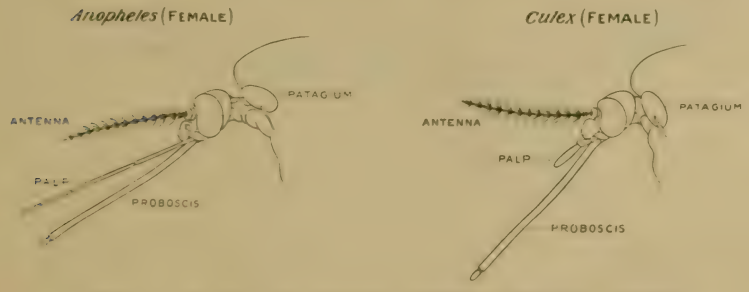


FIG. 22. THE MALARIA AND THE COMMON MOSQUITO. FEMALE.
Suggested by figures of Eysell, in Arch. für Schiffs- u. Tropenhygiene.

proboscis; those of the male are long, but their terminal segment is not enlarged, though set with long hairs (Fig. 22). This furnishes a ready means of distinguishing the Malaria Mosquito from the Culex.

The margin of the chitin bordering on the eyes, appears white or light gray in color. Just behind the light margin is a row of long hairs, which overhang the eyes, and in front a tuft of long hairs and scales overhang the space between the antennæ. The remainder of the head is covered with scales.

The slender and almost transparent neck connects the head with the second division of the body, — the thorax. This is greatly enlarged to accommodate the strong wing-muscles which it contains (Fig. 26). The middle segment, which bears the wings, exceeds the other in size and forms the entire dorsal portion of the thorax.

The delicate membranous wings are strengthened by ribs, or veins, closely beset with scales. The arrangement of scales varies in the different species of mosquitoes. The local Malaria Mosquito is distinguished by the presence of four dark spots in certain characteristic positions on its wings, and hence its specific name "maculipennis," or "spotted-winged" (Fig. 23). These spots are produced by the grouping of the scales of the wing veins into dense tufts at these points. The margin of the wing bears several rows of scales, long

Wings

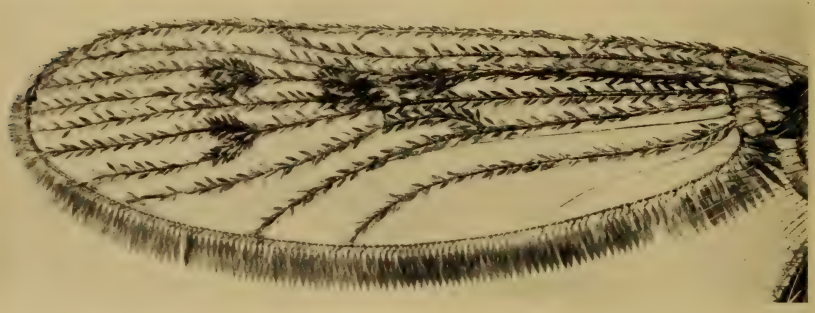


FIG. 23. WING OF ANOPHELES MACULIPENNIS MEIGEN.
Magnification about 20 diameters.

and slender scales alternating regularly with rows of shorter ones, producing a beautiful fringe.

A pair of small club-shaped organs, the "halteres," or balancers, on the third segment of the thorax, enables the insect to maintain its equilibrium, for without them it performs aimless evolutions in the air somewhat after the fashion of a tumbler-pigeon, and it cannot direct its flight. Similar organs are found in all Diptera and they represent a degenerated second pair of wings.

Each of the segments of the thorax bears a pair of legs. Structurally these are simply hollow, jointed tubes of chitin containing the muscles by which they are flexed. Externally they are covered with scales, and in certain places they bear fine hairs. The legs are

Legs

connected to the body by the "coxæ," or hip-joints, which are constructed so as to permit great freedom of movement (Fig. 26). Then follows in each leg, a small piece, the "trochanter," uniting the coxa with the leg proper. Each leg consists of seven pieces. The first is called

FIG. 24. FEMALE ANOPHELES IN CHARACTERISTIC STINGING POSTURE

Photograph of the model (× 75) in the American Museum. Magnification of figure about 10 diameters.

the femur, the second is the tibia, then follow the tarsal joints, five in number, the last of which bears a pair of claws. In the male one of the claws of each foreleg is greatly enlarged. When the mosquito walks or

rests, it supports itself on several of the tarsal joints. The legs of the third pair are, however, used very slightly in walking, but they serve continually as organs of touch, and in flight they help to balance the body and determine its inclination. They are often carried raised and curved forward over the body especially when the mosquito is stinging (Fig. 24).

Abdomen

The abdomen is closely united to the thorax. Its eight rings, or segments, are each composed of an upper and a lower shield of chitin and a soft connecting membrane. This soft "pleural membrane" permits of movements of respiration, as well as of the very considerable distension of the abdomen noticeable in mosquitoes after a full meal. The abdomen tapers gradually toward the tip, and the last segment in the female mosquito bears the ovipositor by means of which the eggs are laid and, with the aid of the hind legs, arranged on

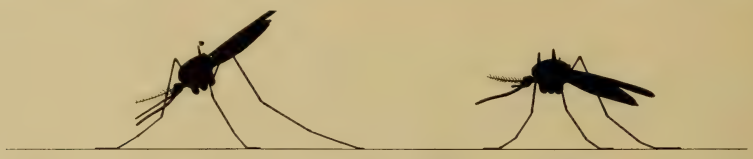

Anopheles.
BODY AT AN ACUTE ANGLE TO THE SURFACE ON WHICH THE INSECT RESTS.
Culex
BODY PARALLEL TO THE SURFACE ON WHICH THE INSECT RESTS.

FIG. 25. CHARACTERISTIC POSITIONS OF THE MALARIA AND COMMON MOSQUITO WHEN AT REST.

the surface of the water. In the male, the last abdominal segment terminates in a pair of claspers (Fig. 17).

Color of Adult

The color of the mosquito can be said in general to range from light yellow to dark-brown and almost black. Some species are nearly colorless, or of a very transparent light green. The Malaria Mosquito is brown, the color increasing at first with age till the chitin becomes thickened. The thorax is dark brown above, with a light stripe in the middle and one on each side of the back. The sides of the thorax and the coxæ are light. The upper shields of the abdomen are dark brown, the lower ones lighter and more yellowish. The legs are dark brown above, sometimes with a purplish tinge, and are lighter below, with distinctly yellow spots at the knee-joints. The proboscis and palps appear very dark brown or purplish black. The back of the thorax and the entire abdomen, the soft membrane excepted, are covered with long, golden hairs.

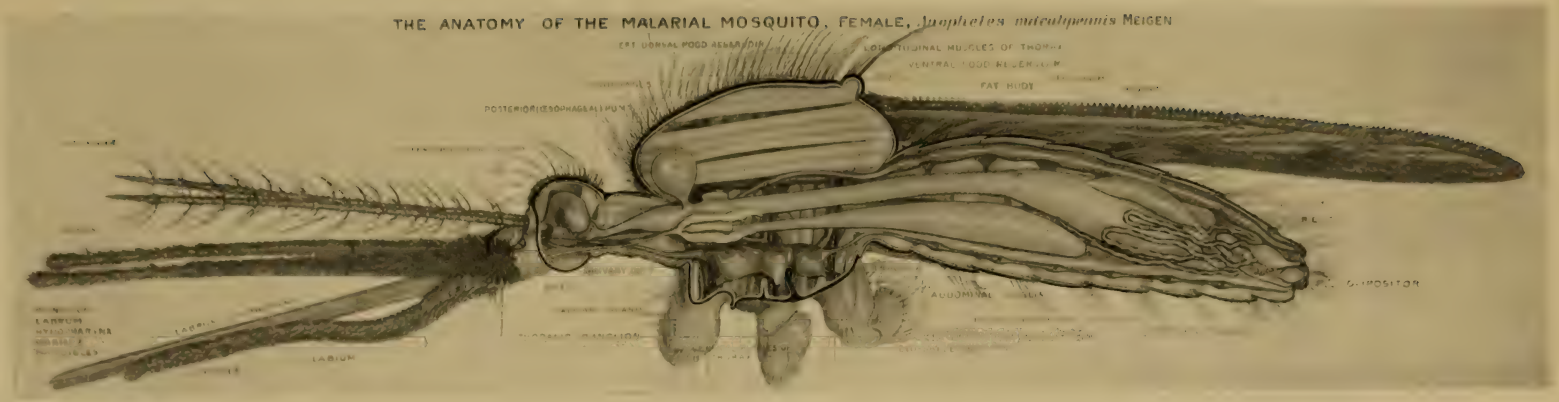


FIG. 26. ANATOMY OF THE MALARIA MOSQUITO.

The figure represents a median section of a female. The mouthparts, the antennæ, the alimentary tract and the nervous and reproductive systems have been left entire. From a photograph of the left side of the model shown in Figure 24. Magnification 20 diameters.

The Internal Organs.

When the mosquito bites, blood is pumped up into the "sucking-tube" by two pumps (Fig. 18). The first and smaller pump lies just above the junction of the labrum with the head and forms a direct continuation with the tube. The second, larger and more efficient pump, lies further back in the head and is dilated by powerful muscles. In section it is triangular, with collapsed walls. When dilated by the muscles it fills with blood from the smaller pump and from the tube beyond. It is then allowed to collapse by its own elasticity, and the liquid is forced on into the œsophagus. This is in great part in the neck of the insect and gives off just beyond its entrance into the thorax, three food reservoirs, two small ones above, and a third elongated sac below, which reach far into the abdomen (Fig. 26). It is the blood stored in this reservoir, which in its greatly distended state may be seen through the thin pleural membrane, that gives to the mosquito the red color noticeable after a full meal. The stomach is a continuation of the œsophagus and is tubular, narrow in front but dilated into a sac behind. At its posterior end is a valve-like constriction just beyond which there open into the intestine five excretory tubules. After one or two rather sharp curves, the intestine is continued to the terminal end of the body.

Pumps

Food reservoirs

The nervous system of the mosquito (Fig. 26) consists of a chain of connected centers, or nerve ganglia. In the head several pairs of ganglia are fused to form the "brain," which supplies nerves to the eyes, antennæ, palps and mouth-parts. In the thorax, just above the origin of the legs, there is another large mass consisting of three pairs of fused ganglia which send nerves to the legs, wings and balancers. The nervous system is continued in the abdomen as a chain of small ganglia, six in number. In addition to this main nervous system a pair of small sympathetic ganglia lie on each side of the alimentary tube, in the anterior part of the thorax.

Nervous System

The large thorax is almost entirely filled with the great muscles of flight, consisting of two masses at right angles to each other (Fig. 26). Their alternate contractions change the shape of the thorax and indirectly serve to move the wings in flight. The wings are also controlled by smaller special wing-muscles. The muscles which move the abdominal segments during respiration lie for the most

Body Muscles

part directly on the hard chitinous pieces which compose the upper and lower shields of the abdomen.

Respiration is carried on by means of a system of air-tubes, or tracheæ, which open to the exterior by two main openings on either side of the thorax, and by eight smaller ones in the soft membrane of the abdomen (Fig. 21). The tracheæ, by repeated branching, ramify throughout the entire body of the mosquito and supply the blood, as well as every organ and tissue, with air. Nearly filling all spaces between the muscles and the organs, are symmetrically arranged masses of a peculiar tissue, the blood-tissue or fat-body, which is especially well supplied with tracheæ.

Respiration

The circulation of the blood of the insect is maintained by the heart, which is a tubular organ lying directly under the upper chitin-shields of the abdomen (Fig. 22). It is continued forward in the thorax as a vessel, the "aorta," through which the blood is pumped to the head. This is the only blood vessel to be found in insects, and the blood circulates with the respiratory movements throughout the body in the interstices between the fat-tissue and the internal organs. Into the blood in the body cavity of the mosquito, the malarial spores which grow in its stomach-wall escape. Through the circulation of the blood the spores then find their way into the salivary or poison glands.

Circulation

These important little glands, which supply the irritating poison of the mosquito bite, lie within the anterior part of the thorax just beyond the neck (Fig. 26). The secretion from each three-lobed gland is conducted forward into the head by a fine tube, the salivary duct. In the head the two ducts join and the common duct empties into the salivary pump (Fig. 18). This, in connection with its continuation, the salivary channel in the hypopharynx, forms a practical syringe by which the poisonous saliva is automatically forced out at the point of the proboscis during the act of feeding. It has been thought that the saliva serves to prevent the clotting of the blood in the mosquito's sucking tube, but this, strangely enough, seems doubtful.[1] Its irritating effect is however well known, and it is, furthermore, with this salivary secretion that the malarial spores are injected into the human circulation.

Poison Glands

[1] G. F. H. Nuttall and A. E. Shipley. Jour. of Hygiene, London, 1900, p. 195.

Malaria.

It was early observed that "malaria" was apt to be prevalent during damp and rainy seasons, and that it occurred principally in exactly such places as are now known to furnish ideal breeding grounds for the Malaria Mosquito. That new cases of malaria appeared at the time of year when the Malaria Mosquito abounded, was also recorded long before it was suspected that the insect was in any way connected with the malady; and one of the old medical writers, mentions as a characteristic of malarial seasons, that "gnats and flies are apt to be abundant."

Malarial Seasons

Asia is considered to have been the original home of malaria and from there it was introduced into Europe. In the fourth century B. C. it had become established in Greece, and since this time it has been endemic in Europe, particularly in the countries bordering on the Mediterranean. Its prevalence in Italy and Greece is historic. It is thought to have been an important factor in the decline of the nations of antiquity.[1]

Original Home of Malaria

Malaria was formerly considered to be a form of ague due to foul air, whence its name, which literally means "bad air." It was attributed to a sort of "miasma." Its true nature did not become known till 1880, when Laveran, a French military surgeon, working at the time in Algeria, discovered the malarial parasite in human blood. Some years later, Professor Manson of England, directed the attention of Major Ross of the Indian Service, to the mosquito as a possible carrier of malarial infection. It had at this time just been discovered that yellow fever was spread by mosquitoes, and Manson had previously, in 1879, found a Culex mosquito carrying the parasite of filarial disease. That the insect might play such a direct and extraordinary rôle as it does in the transmission of malaria, was, however, not suspected even by Manson. In 1897 Ross discovered the presence of the malarial organism in a mosquito of the genus *Anopheles*, and a little later, through the efforts, chiefly of Ross and the Italian, Grassi, the remarkable life-history of the parasite became known in its entirety.

Discovery of Malarial Parasite

[1] W. H. S. Jones. Malaria. A neglected factor in the history of Greece and Rome. London, 1907.

As the result of the laborious researches of these scientists, we now know that malaria is not communicated except by the Malaria Mosquito, that this is a member of the genus *Anopheles*, and that consequently, malaria does not exist in any locality in the absence of mosquitoes of this genus. While it is highly probable that all of the forty or more species of the genus, distributed over almost the entire world, may carry malaria, ability to harbor and transmit the malarial parasites has been actually proven of only about half the number. The majority of the species known to be malarial occur in India. The only European or North American member of the genus which stands at present positively convicted of carrying the disease, is the one figured and described in this paper, *Anopheles maculipennis* Meigen. That other mosquitoes, for instance, the common Culex, of which so many species exist everywhere, are as likely as Anopheles to imbibe malarial blood is unquestionable, but in all mosquitoes, except certain Anopheles, the human malarial parasites seem to perish in the alimentary tract of the insect, or the spores are perhaps destroyed by the more acid secretion of the salivary glands.

Malaria and Anopheles

The malarial organisms are unicellular animals, "protozoa," of the class Sporozoa, all members of which are parasitic. The members of the order to which they belong, the *Hæmosporidiida*, are parasitic in the blood of higher animals and resemble the malarial organisms in their life-history. Thus, there is a parasite of "bird malaria" found in pigeons, crows and bluejays, *Halteridium*, transmitted by a Culex mosquito; and another, *Proteosoma*, which lives in the blood of sparrows and is also carried from one bird to another by a mosquito.

When a malaria-infected mosquito bites, the poison or saliva which is injected into the wound carries into the human circulation some minute needle-like or elongated spindle-shaped bodies. These are the malarial spores (Fig. 32, S). Once in the human circulation, each spore, of which there may be half a hundred, enters a red blood corpuscle (Fig. 27, A, B), loses its characteristic form and becomes a minute, rounded, amœboid parasite. After its entrance, this measures one fifth to one fourth of the diameter of the blood cell; but, nourished by the contents of the corpuscle, it grows rapidly (Fig. 27, C, D). The blood corpuscle in which it lives, loses its circular outline, becomes enlarged, and, in a short time, is nearly filled by the growing parasite (Fig. 27, E). At the same time the nucleus of

The Malarial Spores in the Blood

the malarial amœbule divides, till six to sixteen daughter nuclei may be seen (Fig. 27, E). By the time this nuclear division is complete, almost the entire original contents of the red corpuscle have disappeared, little remaining of it but the thin cell-membrane, filled with the enlarged parasitic mass. At last the wall of the corpuscle bursts, and the parasite is liberated (Fig. 27, H). Its protoplasm has by this time divided into as many parts as there are nuclei, and each resulting part forms a new spore, which in its turn, enters a red blood corpuscle (Fig. 27, A). The same process of growth at the expense of the blood cells is then repeated, and new spores are formed by division, accompanied by the destruction of an

Asexual Multiplication of the Parasites

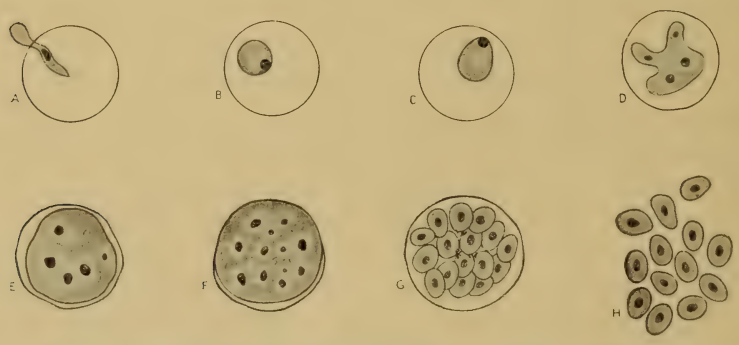


FIG. 27. THE MALARIAL PARASITE. (TERTIAN.) ASEXUAL CYCLE IN THE HUMAN BLOOD.

A. Malarial spore entering a blood corpuscle (schematic). B. C. Malarial parasite in the blood corpuscle. D. Enlarged, amœboid parasite. E. Growth and division of the parasite. H. The malarial blood-spores liberated by the bursting of the blood corpuscle. Magnification 1600 diameters. After Ruge.

ever increasing number of red blood cells. This process of multiplication, which constitutes the asexual cycle in the life of the malarial parasite, may go on for a considerable period, till the blood is filled with billions of minute organisms. In time, however, certain of the spores, after entering fresh corpuscles, do not divide, but they develop into forms of the parasite which, if taken up by a Malaria Mosquito, will conjugate and reproduce sexually (Fig. 28).

These new forms, which are approximately spherical in shape, are of two kinds (Fig. 29, A): larger (A) female (egg) cells, and somewhat smaller (A 2), male cells. The latter give rise to long filamentous sperms

when removed from the human circulation. In the mosquito's stomach these sperms fertilize the female cells, a single sperm uniting with each (Fig. 29, B), and as many as five hundred of these fertilized egg cells have been found in the stomach of a single mosquito. The fertilized egg-cell becomes elongated and pointed at one end (Fig. 29, C), and finally works its way into the stomach-wall of the insect (Fig. 30), where the embryo-cells grow and, in fifteen to twenty days, produce large cysts (Fig. 32, C) each of which is filled with thousands of new needle-shaped spores. These cysts, which are on the outer wall of the stomach (Fig. 31), ultimately burst and the hosts of contained spores (Fig. 32, C, S) are set free in the body cavity and, consequently, in the blood of the mosquito. Some of them find their way into the salivary glands (Fig. 32, G) and then into the salivary ducts, whence, at the insect's next meal, they are again injected with the saliva into the blood of another human individual. In this manner malarial infection is handed on from subject to subject.

Sexual forms of the Parasite

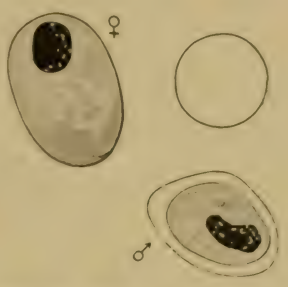


FIG. 28. NORMAL BLOOD CORPUSCLE AND MALE (♂) AND FEMALE (♀) REPRODUCTIVE FORMS OF THE MALARIAL ORGANISM.

Magnification 1600 diameters, after Ruge.

Malarial infection by the "Mosquito bite"

FIG. 29. THE REPRODUCTIVE FORMS OF THE MALARIAL ORGANISM IN THE MOSQUITO'S STOMACH.

(After Schaudinn and R. Koch.)

A. Female, or egg cell. A 2. Male cell giving off sperms. B. Fertilization of the egg-cell. C. The fertilized egg-cell. Magnification 375 diameters.

Forms of Malaria

Three varieties of malaria are distinguished: "tertian," where the fever and chills recur every forty-eight hours; "quartan," where they are separated by an interval of seventy-two hours, and, lastly and most dangerous of all, the irregular

"tropical" malaria, the mild local form of which is known as "æstivo-autumnal." The intervals which separate the paroxysms correspond in length to the duration of the process of spore-formation in the blood cells, the chills marking the liberation of the spores (sporulation). The parasites which produce the three different forms of malaria are considered to be separate species, distinguished chiefly by a difference in the time required for the completion of their cycle of development in the human blood. In this connection it is of interest that immunity against

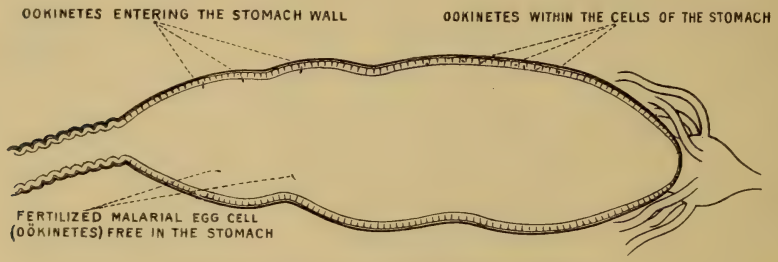

OOKINETES ENTERING THE STOMACH WALL
OOKINETES WITHIN THE CELLS OF THE STOMACH
FERTILIZED MALARIAL EGG CELL
(OÖKINETES) FREE IN THE STOMACH

FIG. 30. STOMACH OF THE MALARIA MOSQUITO.

Oökinetes are shown entering the stomach wall. Diagrammatic. Magnification about 30 diameters.

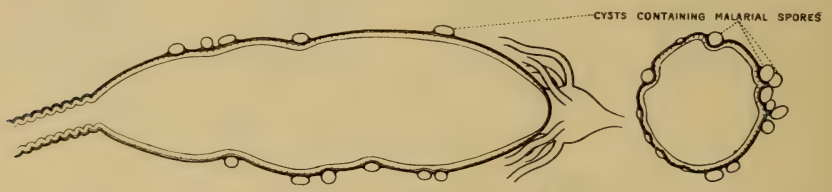


FIG 31. STOMACH OF THE MALARIA MOSQUITO.

Malarial "Sporocysts" are shown on the outer wall of the organ. Longitudinal section diagrammatic. Cross section after Grassi. Magnification about 25 diameters.

one form of malarial organism has been found by Professor Koch not to insure immunity against the other two species. The parasite of the tropical variety differs from the others in respect to the appearance of the sexual forms, which are half-moon or crescent-shaped. It was these which were first found by Laveran, and they are termed the "half-moons of Laveran."

With the extermination of the mosquito of a malarial neighborhood the disease will, in time, disappear. Nuttall on the other hand describes districts in England from which malaria has disappeared, although the

mosquitoes remain. This disappearance of malaria may have been brought about by a general use of quinine. Quinine, obtained from various species of trees of the genus *Cinchona*, growing at high altitudes particularly on the Andes and brought into use in Europe in the year 1640 by the Countess Chinchon, vice-queen of Peru, who had been cured of malaria by its use, is the only known specific against malaria. It will, if properly administered, destroy the parasites of tertian and quartan fever in a comparatively short time. The parasite of tropical fever, however, such as exists in its severest form in certain places on the West Coast of Africa, on the southernmost

Effect of quinine

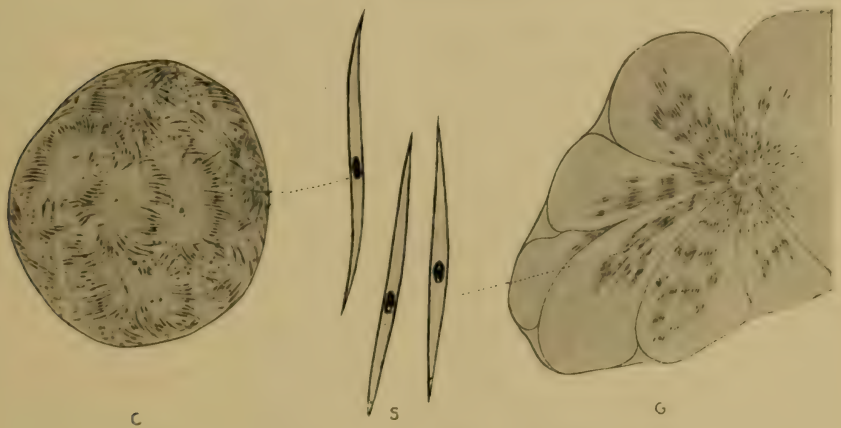


FIG. 32. THE MALARIAL SPORES IN THE MOSQUITO.

C. A sporocyst with contained spores (× 400) (after Grassi). S. The liberated spores (× 3000). G. Section of the salivary gland of the mosquito, malarial spores lying in the cells and in the duct of the gland, (× 350) (after Grassi).

of the Philippine Islands and in the Malay Archipelago, is only slightly affected even by quinine, after the parasite has once begun to multiply in the blood. The sexual forms of the malarial organism are especially resistant and may, long after the destruction of all asexual parasites, take the place of these latter and by simple division give rise to new crops of spores. As a preventive the drug has, however, been found highly serviceable by those obliged to travel or to live in tropical malarial countries.

As an example of a local malarial epidemic may be mentioned an outbreak, described by Dr. W. N. Berkeley, which took place near Jerome

Park in the Borough of the Bronx, New York City, in 1900. A search revealed specimens of *Anopheles maculipennis* in every house and generally in the sleeping quarters wherever the disease occurred. In tropical climates, the natives, who often live in dark and poorly ventilated houses, are the chief sufferers, and we learn that, in India and Africa, from 20 to 100 per cent of the children of the native villages, are affected by malaria.[1] In the southern States of our own country malaria is a severe scourge among the negroes, and probably for the same reasons as in India.

Prevalence of Malaria

The Malaria Mosquito seldom rises even to the second story of a house, and it is a well known fact, that persons whose sleeping quarters are high above the ground are seldom attacked by the disease. Since the mosquito is a poor flyer and does not readily rise high above the ground, and since it avoids an abundance of light, its absence from the upper stories of a building is easily understood.

In general, high altitudes insure a freedom from the Malaria Mosquito and from malaria, but there are some notable exceptions, and malaria has been recorded as endemic in certain regions in India where the elevation is four to five thousand feet above sea-level.

Yellow Fever.

The rôle which mosquitoes play in the dissemination of yellow fever was discovered in 1881 by Dr. Finlay of Havana, and communicated by him in papers on the "Natural History of Yellow Fever" (1881–1886). A suspicion that some insects were concerned in the spreading of the disease had been expressed as early as 1848 by Nott, a physician of Mobile, Ala. Not much credence, however, was given to Finlay's discovery till it had been firmly established that malaria was transmitted by mosquitoes; and the real experimental proof of transmission by the mosquito was furnished by a commission of United States Army surgeons which was sent to Cuba by former Surgeon-General Sternberg for the purpose of carrying on investigations. The findings of the commission, which was in charge of Major Reed, U. S. A., positively demonstrated that yellow fever was communicated by the bite of a "Yellow Fever Mosquito" (*Stegomyia fasciata*

Mosquitoes and Yellow Fever

[1] Stephens and Christopher in Reports to the Malaria Committee of the Royal Society. Sixth series, March, 1902, p. 2, and elsewhere.

Fabricius) which must previously have fed on the blood of a yellow fever patient; that the fever could not possibly spread without the presence of a mosquito, and that simple contact with a yellow fever patient was not dangerous. To assure themselves of the correctness of their conclusions, members of the commission in the course of their investigations even went so far as to sleep for weeks in bed clothing soiled by yellow fever patients.

The organism which causes the yellow fever, has not, up to the present time, been found; but it is in every way probable that it will prove to be a

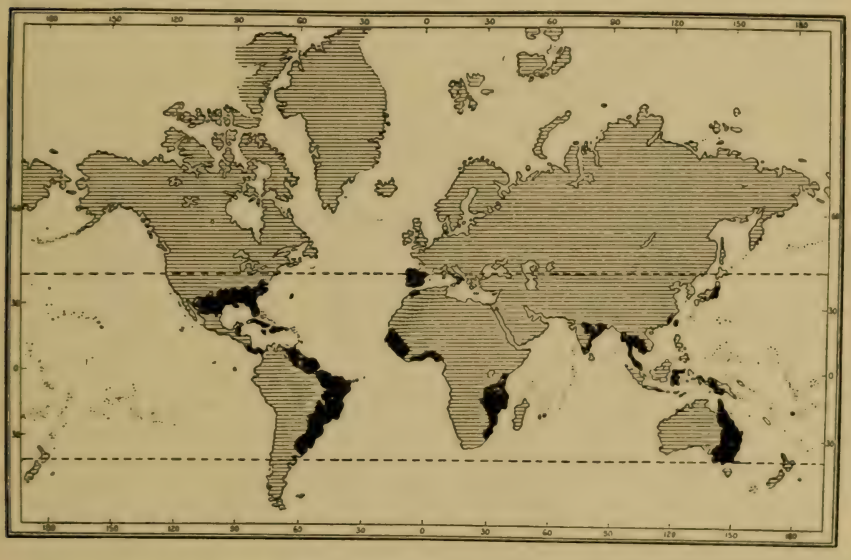


FIG. 33. THE DISTRIBUTION OF STEGOMYIA.
After Theobald.

blood parasite of the class Sporozoa, its life-history resembling in a general way that of the malarial organism. The period of incubation in man, *i. e.*, the period which must elapse between the bite of the infected mosquito and the beginning of the sickness, varies from forty-one hours to not more than six days. The period of its development in the mosquito was found by the commission to be twelve days or more. This fact is of very great importance in relation to quarantine measures, and makes it entirely possible to prevent the introduction of yellow fever into any port where it does not exist.

Period of Incubation

At the same time, the briefness of the period of incubation insures a practical freedom from yellow fever to places where the Yellow Fever Mosquito occurs, if they be distant but six days from an infected port. Hawaii is at present an example of such freedom from the disease, although the Stegomyia occurs there.

The Yellow Fever Mosquito is essentially tropical and sub-tropical. On the American continent its chief habitat is Central and South America

FIG. 34. THE YELLOW FEVER MOSQUITO (*Stegomyia fasciata* Fabricius).

1 and 2 females. 3 male. The figure shows well the banded abdomen, the markings on the thorax and the striped legs. (Magnification about 5 diameters.) From E. A. Goeldi: Os Mosquitos no Pará, 1905.

and the West Indian Islands. It is, however, found in the Southern States, as may be seen on the map, Fig. 33. According to Dr. Howard its life zone, over which it might well spread, includes practically all of the Southern States, as far north as Mason and Dixon's Line. Theobald, of the British Museum, puts its distribution between 48 degrees north and south latitude. That it may be carried

Distribution

far northward and under favorable conditions live, and perhaps breed, is shown by records of yellow fever epidemics in New York and Philadelphia in the early part of the past century. The success of the sanitary work done in Cuba under General Wood bears abundant witness to the effectiveness of measures for the extermination of Stegomyia mosquitoes, and of proper isolation of yellow fever patients from the insect by the simple means of mosquito netting.

The Yellow Fever Mosquito

The Yellow Fever Mosquito is known as a "day mosquito," and was formerly considered a species of Culex. The back of the thorax is marked by silvery stripes, the dark-brown or black sides of both thorax and abdomen are ornamented with conspicuous white spots, and each segment of the abdomen bears a white cross-stripe. The knee-spots of the black legs are white, and the tarsal joints are banded with white. These markings make the mosquito quite easy to recognize.

Insects as Carriers of Disease.

The whole question of the relation of insects to disease is a subject not only of significance to the medical world and of great interest to the naturalist, affording as it does a striking and most recent instance of the relation of medical science to natural history, but it has also become a matter of general and urgent sanitary importance, and as such demands an enlightened public appreciation.

Many kinds of insects have been found to be instrumental in the spreading of disease, either by simply conveying disease germs from one place to another, or by actually harboring germs of parasites, which grow and multiply in the body of the insect till they are transferred by its bite to another animal or a human individual. This latter is the case not only in malaria and yellow fever, but also in many of the other most-dreaded diseases of man and beast, in which an insect has been found to serve as the intermediary host for a disease-producing organism. Our first knowledge of an instance of this kind was gained by the discovery in the proboscis of a species of a Culex mosquito by Professor Manson in India (1879) of the minute parasitic worm which produces the terrible filarial disease, or elephantiasis.[1] Since the time of Manson's discovery new instances of this

Filarial disease

[1] The filarian worms find lodgment in the lymphatic vessels and by blocking the natural flow of the lymph at certain points cause enormous enlargement of parts of the body.

nature have continually come to light. The most notable recent example is, perhaps, the African "sleeping sickness," caused by a protozoan blood parasite, *Trypanosoma*, of which many species causing severe, usually fatal affections have been found in the circulation not only of man and the domestic animals, but also of reptiles and fishes. The insect which serves as the intermediary host is the notorious "tsetse-fly." The fatal "tsetse-fly disease" and the "kalaazar" or "black water fever" are two stock diseases due to this organism. Cattle and horses used for travel are killed by them in a few days. The devastation due to these diseases has been so great that certain districts in South Africa have had to be abandoned by the inhabitants. A constant supply of the parasites is obtained by the flies from numerous wild animals which have in the course of time become immune to the disease. It has been suggested that the extinction of, for example, the horse on the American continent might probably have been due to the destructive agency of some disease-bearing insect.[1] The discovery at Florissant, Colorado (T. D. Cockerell, 1907), of a fossil tsetse-fly would seem to bear out this hypothesis.

Sleeping Sickness

Texas Fever

The well-known "Texas fever" or "red water fever" which has been introduced into many parts of the world and which has occasioned enormous losses to the cattle-breeders of the southwestern part of the United States is another example of a disease that has been conveyed by an insect, and caused by another type of protozoon, *Piroplasma*, parasitic in the blood. The insect in this case is the cattle tick (*Margaropus annulatus* Say). The list is growing, and the investigations which are now being carried on, particularly by the German and English Governments, may prove to be productive of important results.

The Bubonic Plague

English investigations in India and China have just brought to light the mode of transmission of the bacterial bubonic plague. It has been found that a minute flea, which normally lives on gray rats, carries the disease. When the rats die from the plague by thousands, the fleas find human victims and thus epidemics are produced.

In connection with the subject of insects as carriers of disease, the ordinary house fly should not be forgotten, since it disseminates tuber-

[1] H. F. Osborn: The Causes of Extinction of Mammalia. The American Naturalist. Dec. 1906.

culosis, cholera and typhoid fever. The house-fly breeds in decaying matter, and its habits are so filthy, that even if for no other than esthetic reasons, it should be the first object of the general war on pestiferous insects, begun long ago by the agriculturists for economic reasons, but now become also a problem of sanitary importance for which communities and governments will be compelled to spend great sums of money.

The House-fly

Mosquito Extermination.

The study of disease-producing parasites and of the insects concerned in their transmission is not only indicating rational procedures for the extermination of the latter, but also, as in the case of yellow fever, furnishing a scientific basis for such quarantine and preventive measures as are at present carried out by the United States Government in Panama, and to some extent by modern nations everywhere. The far-reaching effect of such discoveries as those described above is difficult to estimate. The stimulus which they have given to research has already proved to be of vast moment. The practical results in tropical countries and colonizing nations will grow, as distant and hitherto almost uninhabitable parts of the world are opened up. In our own immediate neighborhood they have led to a campaign of extermination against the Malaria Mosquito, and indirectly have served to call public attention to the whole tribe of these insects, which, even though they may not all spread human diseases, nevertheless constitute a pernicious pest which renders large areas unfit for habitation. When we consider that within a radius of twenty-five miles of New York there exist two hundred square miles of marsh and swamp land,[1] the local mosquito problem alone will be seen to be far from insignificant. Such a campaign of extermination of mosquitoes as is now being waged in the State of New Jersey under the supervision of Professor Smith would have been considered before the time of the discoveries of Ross and Finlay, not only extravagant, but really insane.

Preventive and Quarantine Measures

The local Problem

When the problem of mosquito extermination on a large scale, first presented itself, it became, of course, necessary to devise effective means

[1] Felt: Mosquitoes of New York State, New York State Museum Bulletin 79, p. 244, 1901.

for its accomplishment. In the light of some knowledge of the habits and life-history of the mosquito, there was no difficulty in discovering that any extensive attempt to cope with the insects must be directed toward its destruction in the aquatic larval and pupal stages. A consideration of the "natural enemies" of the mosquito, which might be taken advantage of for the purpose, would seem to bear out such a decision, for in the case of the adult mosquito, these are practically confined to a few insectivorous birds which fly at dark, while the animals which prey on the larvæ are very numerous.

Practical Methods of Extermination

The systematic investigations of the subject, which have covered the ground very fully, make clear the practical measures that must be used, and the actual work which has been accomplished leaves no more room for any doubt that in civilized communities, mosquitoes may be, if not exterminated, at least reduced in number to a minimum. Professor Howard in his book, "Mosquitoes, How they live, etc.", (1901) gives an account of the work done at his instigation by the national and various local governments, up to that time. The "Report on Mosquitoes" (1905) of the New Jersey Agriculture Experiment Station, contains an account of Professor Smith's extensive investigations, which are put to the most practical use.

Professor Smith finds that the larvæ are eaten by certain shore birds, like sand-pipers, and by other insects and their larvæ, such as the whirligig beetles (*Gyrinidæ*), water-scorpions (*Ranatra fasca*), and especially the larvæ of a diving beetle (*Dytiscus*), one of which was observed in confinement, to kill and eat 434 wrigglers in two days. Tadpoles are found to be practically worthless for the purpose. The most active enemies of the larvæ are small fishes of various kinds, such as minnows, "sunfish," the common "killifish" or "saltwater minnow," the "sheep-head minnow" and the "top minnow." One or more varieties of these or other small fishes, if introduced wherever there is a permanent body of water, will effectually keep mosquito larvæ from hatching. The fish must be carefully selected with reference to their preference in respect to environment, of which an account is to be found in the report mentioned above. The complete absence of larvæ in many places where they would naturally be expected, like cat-tail swamps, may undoubtedly be accounted for by the presence of some species of small fish.

Natural Enemies of the Mosquito

Mosquitoes do not live in running water, and as a matter of fact, the greater number by far, hatch in places where fish could not possibly be maintained, hence other measures for extermination must be resorted to. The use of crude petroleum spread as a thin film on the surface has long been known to kill the larvæ and pupæ, but it is applicable only to small bodies of water, and it is not lasting in its effect. Poisoning of the water must naturally be restricted in its application, but it is effective, and of the agents tried, "phinotas oil" which is highly diffusible, is found to give much the best results. Cisterns, rain barrels and other receptacles in which mosquitoes are apt to breed in large numbers and in which poisoning of the water is not permissible, should be kept covered, while other mosquito-breeding collections of water in which fish cannot be used, should be treated by drainage or filling.

The Use of Oil

The saltwater marshes of New Jersey, which give rise to billions of insects that spread inland, are at present being drained by machine-dug ditches, and at comparatively small cost per square mile. In many cases, the simple introduction of tide-water into the low-lying shore districts, will bring about sufficient movement of the shallow stagnant water of the marshes to reduce greatly the numbers of mosquitoes that hatch.

Drainage

LITERATURE ON MOSQUITOES.

An old work "Micrographia Curiosa" by P. P. Bonnani, published in 1691, contains what is perhaps the first account of the mosquito and its life-history. A "Dissertation de Culice" by Johann Mathews Barth, dates from 1737; the "Bybel der Natuure" (1738) by the Dutch naturalist Swammerdam who evidently was not acquainted with any previous accounts of the mosquito, contains an excellent description of its metamorphoses, illustrated by plates, which surpass many of the illustrations of the insect published in more recent years. After the time of Linnæus the literature, of course, becomes more extensive, but no especially great attention was paid to the family Culicidæ till after the discovery of its disease-carrying propensities. The number of works dealing with the insects from a natural history point of view, is somewhat restricted, but papers treating of the medical aspects of the subject are exceedingly numerous.

Below are enumerated a few of the most important and easily accessible works on mosquitoes and on the subject of insects as carriers of disease. To

all of these, as well as to many others, the writer is indebted for much of the information contained in this paper.

BERKELEY, W. N. Laboratory work with Mosquitoes. New York, 1902. A brief guide, introductory to microscopic work, particularly with salivary glands and the malarial organism.

CHRISTOPHERS, S. R., and STEPHENS, J. W. W. Reports to the Malaria Committee, Royal Society. London, 1900–1903. Brief Reports on Mosquitoes, in relation to Malaria in India, and the East Coast of Africa, also, a short description of the anatomy of the mosquito.

BLANCHARD, R. Les Moustiques. Histoire Naturelle et Médicale. 673 pp. Paris 1905. A comprehensive systematic work.

HOWARD, L. O. Mosquitoes. How they live, How they carry disease, How they are classified, How they may be destroyed. 241 pp. New York, 1901. An excellent popular account.

GILES, GEORGE M. A Handbook of the Gnats or Mosquitoes. Giving the Anatomy and Life-history of the *Culicidæ*, together with descriptions noted up to the present date. 530 pp. 1902.

NUTTALL, G. H. F. On the Rôle of Insects, Arachnids and Myriapods in the spread of Bacterial and Parasitic Diseases of Man and Animals. A critical and historical study. Johns Hopkins Hospital Reports, Vol. VIII, 154 pp. Baltimore, 1899–1900.

NUTTALL, G. H. F., and SHIPLEY, A. E. The Structure and Biology of Anopheles. The Journal of Hygiene, Cambridge and London. Vol. I. 1900.

Contains the results of their admirable and very complete technical study of the structure and biology of the malaria mosquito.

SMITH, JOHN B. Report of the New Jersey State Agricultural Experiment Station, upon the Mosquitoes occurring within the State, their Habits, Life-History, etc. Trenton, 1905.

A comprehensive and interesting report of Professor Smith's thorough investigation, from a practical as well as purely scientific point of view, of the natural history of the mosquito, and the methods which should be used in its extermination.

RUGE, REINHOLD. Einführung in das Studium der Malaria Krankheiten mit besonderer Berücksichtigung der Technic. 2te Auflage, Jena, 1906.

An excellent, clear exposition of scientific knowledge of malarial parasites and the clinical aspects of malaria, well illustrated.

THEOBALD, FRED V. A monograph of the Culicidæ or Mosquitoes of the World, mainly compiled from the collections received at the British Museum from various parts of the world, in connection with the investigation into the cause of malaria, conducted by the Colonial Office and the Royal Society. 4 Vols. London, 1903.

The only comprehensive and thorough, systematic account of the mosquitoes of the world.

No. 11.— THE MUSICAL INSTRUMENTS OF THE INCAS. By C. W. Mead, Assistant in Archæology. July, 1903. *Price*, 10 *cents*.

No. 12.— THE COLLECTION OF FOSSIL VERTEBRATES. By W. D. Matthew, Ph. D., Associate Curator of Vertebrate Palæontology. October, 1903. *Price*, 10 *cents*.

No. 13.— A GENERAL GUIDE TO THE AMERICAN MUSEUM OF NATURAL HISTORY. January, 1904. *Out of print*.

No. 14.— BIRD'S NESTS AND EGGS. By Frank M. Chapman. Associate Curator of Mammalogy and Ornithology. April, 1904. *Reprinted*, February, 1905. *Price*, 10 *cents*.

No. 15.— PRIMITIVE ART. July, 1904. *Price*, 15 *cents*.

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The American Museum Journal

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THE AMERICAN MUSEUM OF NATURAL HISTORY

THE HABITAT GROUPS OF NORTH AMERICAN BIRDS

By FRANK M. CHAPMAN

GUIDE LEAFLET No. 28

FIFTH EDITION JANUARY, 1930

THE HABITAT GROUPS

OF

NORTH AMERICAN BIRDS

IN THE

AMERICAN MUSEUM OF NATURAL HISTORY

BY

FRANK M. CHAPMAN

Curator of Ornithology

GUIDE LEAFLET No. 28

FIFTH EDITION REVISED AND ENLARGED

PUBLISHED BY THE MUSEUM

New York, January, 1930

CAMP AT PTARMIGAN PASS, CANADIAN ROCKIES

THE HABITAT GROUPS OF NORTH AMERICAN BIRDS

in the

American Museum of Natural History

By Frank M. Chapman
Curator of Ornithology

THESE groups of birds are designed to illustrate not only the habits but also the haunts or "habitats" of the species shown. Each group usually includes the nest, eggs and young, besides the adult bird or birds, with a reproduction of from 60 to 160 square feet of the nest's immediate surroundings. To this accurate and realistic representation of the home of the species is added a painting from nature of its habitat, the real foreground being connected with the painted background in such a manner that often one does not see where the former ends and the latter begins. The whole, therefore, gives an adequate conception of the nature of the country the birds inhabit and the conditions under which they live.

It should be clearly understood that these backgrounds are not more or less fanciful sketches of the haunts of the birds associated with them, but they are careful studies from nature of definite localities, and therefore possess a geographical as well as an ornithological value. When selecting subjects for treatment, an effort was made to include the birds of widely diversified types of country, in order that the series, as a whole, should portray not only the habitats of certain American birds, but America as well. From the Bahamas and the southern end of the Mexican tableland to Hudson Bay and Bering Sea, from the Atlantic to the Pacific, localities are represented which show at least the more characteristic phases of our landscape, and it is hoped that a tour through this hall of Habitat Groups will not only yield information in regard to North American birds, but also give one some conception of the appearance of the land in which they live.

Some subjects were in nearby places and were easily visited; others were in remote regions and were reached with more or less difficulty.[1] It is estimated that about 90,000 miles have been traveled to secure the material on which the groups are based.

All but three groups in the series, beginning with Bird Rock in the Gulf of St. Lawrence, in 1898, are the result of special Museum ex-

[1]The narrative of many of these expeditions is contained in "Camps and Cruises of an Ornithologist," by Frank M. Chapman.

peditions in charge of the Curator of Ornithology, usually accompanied by a preparator, and one of the artists whose names appear in connection with the backgrounds they have painted.

After arriving, before securing specimens, the birds were first studied and photographed at short range from an especially constructed umbrella-blind. This was sometimes placed in the very heart of the bird community, as, for instance, with the Flamingoes and Pelicans; or even in the tree-tops as with the Egrets. At the same time the artist made studies on which to base the final background, as well as detailed color sketches of leaf and blossom, while the preparator collected the needed accessories, making casts or preserving vegetation in various solutions as occasion required. When the field-work was concluded, the crates of branches, carefully packed boxes of foliage, nests, birds and photographic plates, sacks of earth and other material, according to the nature of the subject, were shipped to the Museum, subsequently to be prepared in the laboratories.

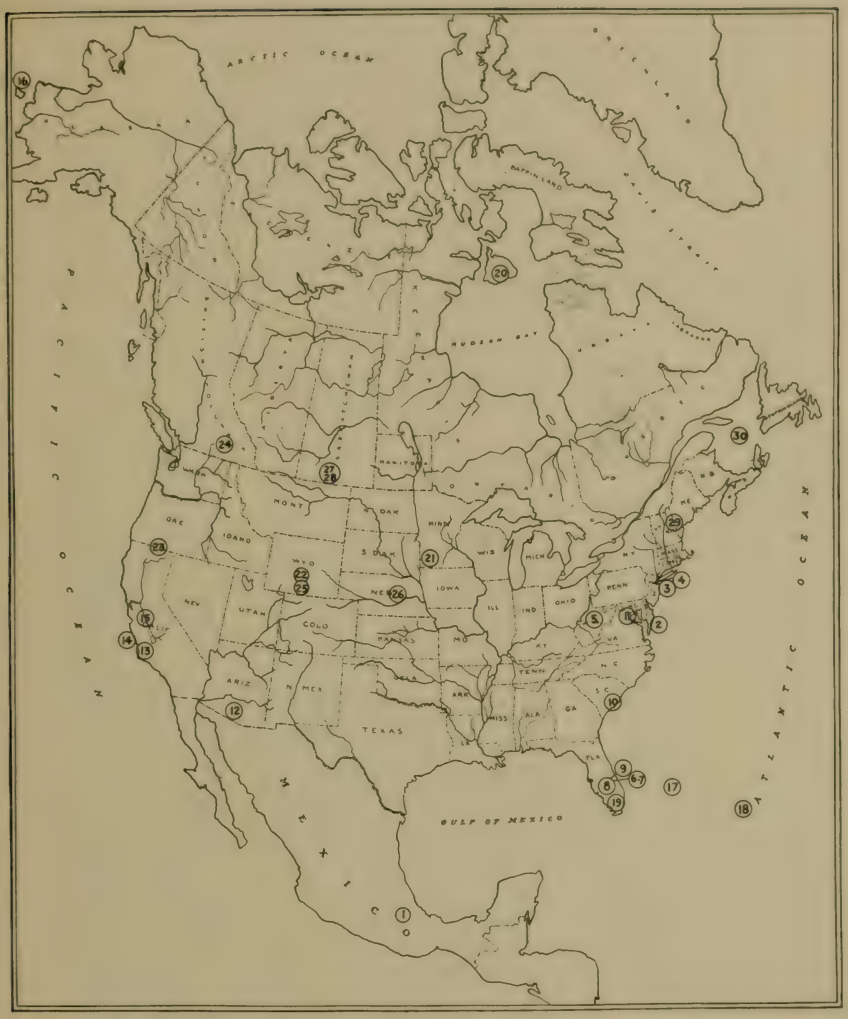
The vegetation, by Mr. J. D. Figgins, Mr. A. E. Butler and other members of the Department of Preparation, has been reproduced in wax, either from plaster molds of the original, or by careful duplication of the original itself. The color has been applied with an air-brush or atomizer, by which the most delicate tints and textures are faithfully rendered.

Each group has demanded its own special treatment, and, in the construction of the series, the many novel problems encountered have resulted in the development of original methods. This is particularly true of the manner of installation and illumination of the groups at the sides of the hall. Here, it will be observed, the background is curved, with the front opening so reduced in size that at the proper distance, or "correct viewpoint," neither the ends nor the top of the group can be seen. By thus leaving the actual limits of the group to the imagination, the illusion of space and distance is greatly heightened.

The groups are illuminated from above by diffused electric light.

The Museum owes this series of Bird Groups primarily to the generosity of a number of its members, without whose contributions the collection and preparation of the material would not have been undertaken.

For this valuable coöperation the Museum is indebted chiefly to Mr. John L. Cadwalader and to Mrs. Morris K. Jesup, Mrs. Philip Schuyler, John B. Trevor, Mrs. Robert Winthrop, Mr. F. Augustus Schermerhorn, Mr. H. B. Hollins, Mr. Henry Clay Pierce, Mr. Henry W. Poor, Mr. Courtenay Brandreth, and Mr. James C. Carter.



Map indicating localities represented by the groups

1. Mount Orizaba, Vera Cruz, Mexico
2. Cobb's Island, Virginia
3. Duck Hawk on Palisades
4. Hackensack meadows, New Jersey
5. Wild Turkey, mountains of West Virginia
6-7. Florida Great Blue Heron and Anhinga, near St. Lucie, Florida
8. Sandhill Crane, Kissimmee Prairies, Florida
9. Brown Pelican, Pelican Island, Florida
10. American Egret, coast of South Carolina
11. Turkey Buzzard, Plummer's Island, Potomac River, near Washington, D. C.
12. Cactus Desert, Tucson, Arizona
13. California Condor, Piru Cañon, southern California
14. Brandt's Cormorant, Monterey, California
15. San Joaquin Valley, California
16. Arctic Seabirds, Diomede Islands, Bering Strait
17. Flamingoes, Andros Island, Bahamas
18. Booby and Man-o'-war Bird, Cay Verde, Bahamas
19. Cuthbert Rookery, southern Florida
20. Whistling Swan, Southampton Island, Hudson Bay
21. Whooping Crane, Heron Lake, Minnesota
22. Golden Eagle, Bates Hole, Wyoming
23. Klamath Lake, Oregon-California
24. Arctic-Alpine Bird-Life, Ptarmigan Lake, B. C.
25. Sage Grouse, Medicine Bow, Wyoming
26. Prairie Hen, Halsey, Nebraska
27-28. Wild Goose and Grebes, Crane Lake, Saskatchewan
29. Loon, Lake Umbagog, New Hampshire
30. Bird Rock, Gulf of St. Lawrence

THE ORIZABA GROUP

The observer is looking across the valley of the Rio Blanca, over the tropical forest, to Mount Orizaba.
Background by Bruce Horsfall. Birds by Harry Raven and Walter Escherich.

1. THE ORIZABA GROUP

A Study of the Influence of Altitude on the Distribution of Life

FROM the dense tropical forests, at the base of Mount Orizaba in Vera Cruz, Mexico, one may look upward toward the equally grand forests of pines and spruces which, 10,000 feet higher, cover the sides of the mountain.

In the luxuriant vegetation are Parrots, Toucans, Trogons, Motmots, and many other tropical birds; and from their home one may see the zone where Crossbills, Evening Grosbeaks, Juncos, Brown Creepers, and other boreal birds are nesting. Owing to differences in altitude, which are the equivalent of differences in latitude, the three great Life Zones which go to make up the faunal regions of North America are thus represented in this one group, which may be said to epitomize all the other groups contained in this hall.

The studies for this view of Mount Orizaba were made at Cordova (altitude 3,500 feet) at the upper border of the Tropical Zone. The primeval tropical forest having long since been cut off in this region, it was necessary to descend to a level of about 1,000 feet, near Motzorongo, to secure studies for the forest depicted. The accompanying view of the Rio Blanco was also made near this point, from which Mount Orizaba may be seen in the same relation as it is here painted.

The birds contained in this group are representative species of the tropical portions of the State of Vera Cruz. They have been selected to show the tropical character of the bird-life of this region, rather than the bird-life of any particular part of it; and represent but a small part of the avifauna of several hundred species.

A GLIMPSE OF COBB'S ISLAND

Background by Walter Cox. Birds by H. C. Denslow.

2. SUMMER BIRD-LIFE OF COBB'S ISLAND, VIRGINIA

A SHELL-STREWN sand-bar seven miles long and about the same distance from the mainland, Cobb's Island, off eastern Virginia, is an ideal resort for sea-birds. Here they are beyond the reach of most bird enemies, while the surrounding waters furnish an unfailing supply of food. The home of the birds has little or no value as "real estate"; they themselves are unfit for food, and it might have been supposed that their continued existence was assured, but about thirty-five years ago they suddenly acquired a commercial value. Their plumage became fashionable for millinery purposes. As a result, thousands of birds were slaughtered on their nesting-ground, and within a few seasons some of the most abundant species were practically exterminated.

At no place were more birds killed than on Cobb's Island and the islands immediately adjoining it. In a single day, 1,200 Least Terns were shot on Cobb's Island; in three days three baymen killed 2,800 Terns in the same locality; at the end of two seasons the Least Terns, for which there was especial demand, no longer existed in this region, and the Common Terns were greatly reduced in numbers. Fortunately the State of Virginia passed a law prohibiting the killing of these birds, and for several years the National Association of Audubon Societies provided a warden to enforce this law during the nesting season. In response to this protection the birds have greatly increased in numbers.

Besides the Common Terns, Skimmers, Gull-billed Terns, Oystercatchers and Wilson's Plovers now nest on the beach of Cobb's Island; while in the marshes which flank the beach on the bay, or west side, numerous Laughing Gulls, a few Forster's Terns and many Clapper Rails, or Marsh Hens, make their nests.

THE DUCK HAWK ON THE PALISADES

Background by Hobart Nichols. Birds by John Rowley.

3. THE DUCK HAWK ON THE PALISADES

THE Duck Hawk is the American representative of the Old World Peregrine Falcon, from which it differs but slightly in color and not at all in general habits.

By falconers the Peregrine was esteemed only second to the Arctic Gyrfalcons. The latter could be owned and flown only by members of the royal family, while no one of lower rank than an earl was permitted to use a Peregrine.

Possibly the restrictions imposed on the owning of Gyrfalcons arose from the difficulty with which the birds were obtained rather than from their superiority as hunters. In this respect the Peregrine, or Duck Hawk, is probably not excelled by any other bird of prey. Its speed enables it to overhaul with ease the swiftest-flying ducks, while it has sufficient strength to strike and kill them in the air and bear them away.

The Duck Hawk is fearless in pursuit of its prey and will dash down and capture a wounded bird within reach of the sportsman's arm; and will repeat the attempt even if fired at and missed.

Peregrines in slightly varying forms are found throughout the greater part of the world. The Duck Hawk, the American form, breeds locally throughout most of the United States, and migrates as far south as Chile. When migrating, it is sometimes not uncommon along our coasts, since it travels with the flocks of wild fowl on which it preys, but when nesting it is generally rare.

In the vicinity of New York City Duck Hawks are known to nest only on the Palisades of the Hudson, where they are unfortunately molested by egg-collectors, and among the hills and mountains to the northward. It is believed that, in the spring of 1908, three pairs were nesting on the Palisades.

In this region Duck Hawks begin to lay in March. They build no nest, but lay their eggs, as may be observed, on the bare rock.

The material for the present group was collected by R. B. Potter on Hook Mountain, near Nyack, N. Y., but it is here shown against a background representing the Palisades, northward from the "Gorge" at Englewood.

AUGUST BIRD-LIFE OF THE HACKENSACK MEADOWS

Background by Bruce Horsfall. Birds by Ernest W. Smith.

4. AUGUST BIRD-LIFE OF THE HACKENSACK MEADOWS

THE thousands of acres of marshland bordering the Hackensack River and Newark Bay, so familiar to travelers over the railways which pass through them, abound in interest to the naturalist.

In their lower portion, colonies of Florida Gallinules and Pied-billed Grebes have been found nesting; but it is in August that birds are most abundant in the marshes, and they then possess the strongest attraction for the ornithologist. At that season the wild rice begins to ripen, bringing to the marsh a large, though ever decreasing, number of Bobolinks and Sora Rails that delight to feed upon it.

The Bobolink is then in its streaked, sparrow-like plumage, and is known under the name "Reedbird."

The Sora, in spite of its small size and sluggish flight, is ranked as a game bird, but at the present rate of decrease it will pay the penalty of this distinction by practical extermination in this region. Red-winged Blackbirds also come to feed on the rice.

During the latter half of July, August and September, Swallows (by far the most abundant birds of the meadows) use the marshes as dormitories, coming to them in incalculable numbers in the evening to sleep, and leaving them early the following morning to radiate to every point of the compass. During the day, and as the birds gather for their evening flight, they may be seen perching in long lines on roadside telegraph lines.

In August the marshes are as remarkable for their flowers as for their birds. The great rose mallow is doubtless the most beautiful, as it is also one of the most abundant species, acres sometimes being pink with the bell-shaped flowers. There are also brilliant cardinal flowers, sagittaria, pickerel weed, jewel flowers, all of which are shown in the group, and many other species.

The studies for this group were made about one mile south of Little Ferry, N. J. The view shown is toward the west.

With the so-called "march of civilization," all this wealth of bird and plant life is bound to disappear, to be replaced by railways, factories and docks.

Background by Bruce Horsfall. Birds by Ernest W. Smith.

5. THE WILD TURKEY IN THE MOUNTAINS OF WEST VIRGINIA

THE Wild Turkey, in spite of its name, is distinctly an American bird, which formerly ranged throughout the wooded portion of the eastern United States, from southern Maine and southwestern Ontario, south to Florida and southwest to New Mexico and Arizona, whence it extends southward onto the Mexican tableland.

It has now become rare or extirpated in the more settled portions of its range and is not found north of Pennsylvania.

Throughout its wide range, the Wild Turkey presents some variations in color, the extremes of which are shown by the Eastern Wild Turkey and the Mexican Wild Turkey. These birds differ chiefly in the color of the tips of the tail-feathers and upper tail-coverts, which in the eastern bird are chestnut, and in the Mexican bird, whitish.

Singularly enough, our barnyard Turkey is descended from the Mexican bird, which the Spaniards found among the Aztecs in a state of domestication. It was introduced from Mexico into Europe, where it had become well established in 1530, and from Europe was brought by the colonists to eastern North America.

Although the domesticated bird will readily cross with the wild one, no extensive effort has been made to domesticate the latter, and the inhabitants of our barnyard still show the whitish-tipped tail and tail-coverts of their Mexican ancestors.

FLORIDA GREAT BLUE HERON

Background by Bruce Horsfall. Birds by H. C. Denslow.

6. FLORIDA GREAT BLUE HERON

THE Great Blue Heron, often miscalled "Crane," is distributed throughout North America. On the humid northwest coast it is darker than in eastern North America; in the arid Great Basin region it is paler; and the Florida form shown here, known as Ward's Heron, is somewhat larger than the others.

Herons are more aqautic than Cranes and feed largely on fish. In the Eastern States they invariably nest in trees, but in the West they often nest among the reeds like Coots. Young Herons are born in a more or less naked condition and are reared in the nest; Cranes are hatched with a downy covering and can run about shortly after hatching. Herons fly with a fold in the neck, but Cranes hold the neck outstretched.

On the ground the Heron is a rather homely object, with his lanky form and long legs and neck, but in flight, his neck folded, the great wings, slowly flapping, bear him on his stately way. Rarely he sets his wings and soars grandly in lofty circles.

In hunting, he either stalks patiently, lifting his feet and setting them down with the greatest deliberation and care, or stands even more patiently waiting. In either case a lightning-like thrust of his beak brings the frog, fish, reptile or even mouse which constitutes his fare.

The Great Blue Heron's eggs are pale blue, unmarked, two and a half inches long. Three or four form a set.

The Heron's notes are loud squawks.

THE SNAKE-BIRD OR WATER-TURKEY

Background by Bruce Horsfall. Birds by Ernest W. Smith.

7. THE ANHINGA, OR WATER-TURKEY, IN FLORIDA

THE fact that the Anhinga resembles both a turkey and a snake sufficiently to have received the names "Water-turkey" and "Snake-bird" is an excellent commentary on the peculiarity of the bird's appearance and habits.

The first-mentioned name finds its origin in the highly developed, broadly tipped, turkey-like tail. The second relates to the long, slender, snake-like neck, and when the bird swims with its body submerged and only the long, shining neck, head and sharply pointed bill above the water, the resemblance to a serpent is greatly increased. (See bird in group.) It may be added that the bird's book name of "Anhinga" is of Portuguese origin and means snaky.

The Anhinga is equally at home in the water and high in the air, combining in an unusual manner the habits of an aquatic and an aërial bird. Its form, close plumage and broadly webbed feet—all four toes being united by membranes as in the Cormorants—admirably fit it for life in the water, and it not only dives with great ease, but pursues and captures its prey under water, the tip of the bill being provided with fine, tooth-like serrations to enable it to grasp its slippery victims.

After prolonged submersion, the Anhinga's plumage, in spite of its texture, becomes more or less saturated with water, hence the bird, while drying its feathers, stands with wide-open wings. (See bird at right.)

The Anhinga's webbed feet make it at home in the water, but it is the bird's tail which renders it, for a diving bird, equally at ease in the air. With spread wings and tail it soars in circles, hawk-like, for long periods, evidently for the pleasure it finds in this exhilarating form of exercise.

Anhingas are hatched naked and are reared in the nest, which is a remarkably well made structure. When a few days old, a buff down begins to appear, which soon covers them. Like the young of Pelicans and Cormorants, they secure their food from the parent's throat.

The background represents a "bonnet," or yellow pond lily lake with its surrounding cypresses and palmettoes, 17 miles west of St. Lucie, Florida.

THE SANDHILL CRANE IN FLORIDA

Background by Bruce Horsfall. Birds by Herbert Lang.

8. THE SANDHILL CRANE ON THE KISSIMMEE PRAIRIES

IN 1632, when Morton wrote of New England birds, "of Cranes there are a great store—they sometimes eate our corne and doe pay for their presumption well enough—a goodly bird in a dishe and no discommodity," he referred to the species in this group. At that time it was doubtless common throughout North America; now it nests in Florida only, of the Atlantic Coast States, while in the interior it breeds only locally west of Wisconsin.

In Florida, the Sandhill Crane is still to be found on the great Kissimmee Prairies and their adjoining low, pine-grown lands, where the studies for the present group were made. Here, in March, it commonly builds its little island nest in the water-filled depressions thickly grown with a species of pickerel weed locally known as "bull-tongue."

Nest-building is preceded by the singular antics of courtship, when both males and females hop, skip and jump about one another, bowing low and leaping high, all the time croaking and calling. Their matrimonial affairs settled, one hears only the loud but sonorous trumpeting of the male which, when heard near by, is harsh and rasping, but, when softened by distance, becomes one of the most attractive sounds of a Florida dawn.

Although superficially resembling Herons, Cranes are more nearly related to the Rails. Young Cranes, like young Rails, are born thickly covered with down, and they run shortly after leaving the egg. The young Heron, on the contrary, is hatched scantily covered with hair-like feathers and spends over a month in the nest. Cranes further differ from Herons by flying with the neck fully extended (see the birds in the painting), while Herons fly with a fold in the neck which brings the head nearly back to the shoulders.

Cranes are less aquatic than Herons. One may see them walking about the pine woods or over the prairies, dignified, stately figures, hunting for seeds, roots, grasshoppers, snails or lizards, while near the water, frogs are captured.

PELICAN ISLAND, INDIAN RIVER, FLORIDA

Background by Bruce Horsfall. Birds by Ernest W. Smith.

9. THE BROWN PELICAN ON PELICAN ISLAND, FLORIDA

BROWN Pelicans normally nest in bushes, and when the birds first came to Pelican Island, Florida, the island was covered with mangroves, in which the birds placed their nests. Severe frosts and over-use by the Pelicans killed all but a few trees. When these were occupied by from two to five nests each, the remaining birds built their nests on the ground, most of them resorting to a sandbar at the east end of the island, where they were as thickly grouped as the painting indicates.

The young Pelican (ground nest, front, left, in the group) is born naked. When about ten days old a downy plumage begins to appear, which soon changes the bird from black to snowy white (ground nests, rear and front). The brown flight-plumage now begins to grow, showing first in the shoulders and humeri (ground nests, front, center and right), and at the age of about two months this plumage is fully developed.

The young are fed on predigested fish regurgitated by the old bird into the tip of the pouch (ground nest, left, rear). Later the young birds (sometimes all three at once) eagerly thrust their heads into the parent's mouth and get their first fish from the base of its pouch. Possibly in this habit may be found the origin of the myth in which the parent Pelican opens her breast to supply nourishment for her offspring. When the young Pelican secures fish longer than it can swallow, it sits with the tail projecting from its mouth, patiently waiting for the head to digest (ground nest, center, front).

The inhabitants of Pelican Island have often been wantonly molested by man, and at times the vandalism of tourists, who killed the birds and robbed them of their eggs, has threatened the existence of this remarkable colony. To prevent so unfortunate a catastrophe, President Roosevelt set aside Pelican Island as a government reservation, and a warden was employed to guard it during the nesting season. But even these precautions proved insufficient. The building of houses on the nearby mainland evidently disturbed the Pelicans, and they abandoned the island to nest upon others farther north. Fortunately this group is an adequate representation of the bird-life of this famous but now deserted home of the Brown Pelican.

THE AMERICAN EGRET IN A SOUTH CAROLINA CYPRESS FOREST

Background by Bruce Horsfall. Birds by Herbert Lang.

THE AMERICAN EGRET IN A SOUTH CAROLINA CYPRESS FOREST
Background by Bruce Horsfall. Birds by Herbert Lang.

10. THE AMERICAN EGRET IN A SOUTH CAROLINA CYPRESS FOREST

ANYONE who knows how abundant the Snowy "Herons" or Egrets once were in our Southern States may be surprised to learn that no little difficulty was experienced in finding a locality where the necessary studies could be made for an Egret group. So effectively, indeed, have the plume-hunters done their work, that it was feared that this beautiful and fast-vanishing species could not be included among the Habitat Groups, when, quite by chance, a colony of Egrets was heard of on a shooting preserve in South Carolina. It appears that when the land was acquired it contained a few Egrets, survivors of a once flourishing colony. The new owners rigidly protected them, and they soon began to increase, forming at the end of seven years a rookery which would have done credit to the days of Audubon.

The nests were in cypresses at an average height of forty feet, and the birds were studied and photographed from a moss-draped blind attached to the limb of a tree forty-five feet above the water.

Sketches for the background were also made from the trees in order to secure the desired effect of height.

The plumes or "aigrettes," for which this Heron and its near relatives inhabiting the warmer portions of the world have been slaughtered, are worn by both sexes. They are acquired prior to the nesting season and constitute the birds' wedding costume, to be displayed as the pose of the bird in the group indicates. As the season advances and they become frayed and dirty, they are shed.

Aigrettes are to be secured, therefore, only during the period of reproduction, and this fact, added to the Heron's communal habits, accounts for the surprising rapidity with which the birds have been brought to the verge of extinction. Concealed in the rookery, it is a simple thing to shoot the parents as they return with food for their young; and in the early days of "pluming" it was not unusual for a man to kill several hundred birds at a sitting.

As a result of the activity of the National Association of Audubon Societies in guarding rookeries, these birds have continued to increase in numbers, and in midsummer, after their nesting season, it is not unusual to see them in the vicinity of New York City.

THE TURKEY BUZZARD

Background by Hobart Nichols. Birds by Herbert Lang.

11. TURKEY BUZZARD

WIDELY distributed over temperate and tropical America, the Turkey Vulture—or, as it is more commonly called, Turkey Buzzard—is a familiar bird in many parts of the South, where it may be seen gravely stalking about in search of food or gracefully soaring in wide circles overhead.

As Bendire has written: "They look their best aloft as their flight is exceedingly easy and graceful, while the apparent absence of all effort as they sail in stately manner overhead, in ever changing circles, and without any apparent movement of their well shaped wings, makes them really attractive objects to watch; but let them once descend to the ground or alight in a tree, and attractiveness ceases ; now they are anything but prepossessing, and it requires no effort to place them where they properly belong—among the scavengers of the soil."

The locality shown is Plummer's Island, in the Potomac, just above Washington, looking up the river toward a stretch of rapids known as Stubblefield Falls. This island is the headquarters of the Washington Field Naturalists' Club, an organization that includes many of our best known naturalists, and is their favorite week-end resort.

A CACTUS DESERT AND ITS BIRD-LIFE

Background by Bruce Horsfall. Birds by H. C. Denslow.

12. A CACTUS DESERT AND ITS BIRD-LIFE

THE great cactus-covered deserts, so characteristic of the more arid portions of Mexico, push a well developed arm northward into Arizona, forming too marked a feature of North American scenery to be omitted from any series of representations designed to include at least the more pronounced types of our landscape.

Since this region has no colonies of birds, and no one bird of sufficient size to be treated alone, it was decided to prepare a group which should show its common birds as well as its commoner forms of vegetation.

Tucson, in southern Arizona, was selected as a suitable locality for our studies, throughout which we had the invaluable advice of Dr. D. T. MacDougal, Director of the Desert Botanical Laboratory of the Carnegie Institution, which is situated at this point.

At the time of our visit (May 9–20, 1906), the desert vegetation was at its best, and looking out over the variously colored blossoms it was difficult to believe that we were not in a land of great fertility.

The birds of this region, like its plants, are of Mexican origin. Along the "washes," which after rains in the mountains are streams for a brief period, mesquites and acacias grow abundantly, and here such brightly colored birds as Cardinals and Vermilion Flycatchers are found. Where this irregular but natural type of irrigation is lacking, the vegetation is chiefly of cactus, which, affording but little shelter for birds of bright colors, is inhabited chiefly by species of neutral-tinted plumage.

Here Mockingbirds and Thrashers (chiefly *Toxostoma curvirostre palmeri*), Cactus Wrens, Roadrunners, Gambel's and Scaled Quail, Texas Nighthawks, Inca, White-winged and Mourning Doves and Black-throated Sparrows abounded, while Gilded Flickers and Crested Flycatchers (*Myiarchus*) nested in the giant cacti.

The making of the vegetation for this group called for unlimited skill and patience on the part of the preparator. The cactus shown is a facsimile reproduction of the original. Before making the plaster molds, every one of the hundreds of spines was carefully removed. After the casts had been taken from the mold (the Opuntia in wax, the others in plaster) they were colored from field studies of growing plants, and the original spines were then set in their proper places.

CALIFORNIA CONDOR IN PIRU CAÑON

Background by Charles J. Hittell. Birds by Ernest W. Smith

13. THE CALIFORNIA CONDOR

LEWIS and Clark found the California Condor as far north as the Columbia River in Oregon, and, at this time, it was distributed southward through California to northern Lower California. This was assuredly a surprisingly restricted range for a bird possessing such unusual powers of flight; but it now occupies an even smaller area, being found only in the Coast Ranges of southern California, from Monterey County southward.

The Condor's rapid decrease is believed to have been occasioned by its feeding on the poisoned carcasses of cattle exposed by ranchmen as bait for bears, panthers and wolves. Since these predaceous animals have now become exterminated or greatly decreased, this unfortunate custom has been abandoned and the Condor is now holding its own.

The California Condor weighs from 20 to 25 pounds, and while not so heavy a bird as the Condor of the Andes, slightly exceeds it in stretch of wing, the average California Condor measuring about nine feet from tip to tip, When flying, the Condor bears a strong resemblance to the Turkey Buzzard, but when the two are seen together the Condor's much greater size is pronounced, while its white under wing-coverts are conspicuous as the bird soars overhead.

The Condor lays its single egg in crevices in the rocks or in caves without pretense of nest, in February and March, and the researches of Finley and Bohlman show that the young bird is between four and five months old before it makes its initial flight.

Studies for the present group were made in Piru Cañon, some twenty miles north of the village of Piru, and fifty miles southeast of Santa Barbara, where for many years a pair of birds had nested in a cave which pierced the vertical cañon wall 150 feet above the water. The visitor is supposed to be in the Condor's cave, from which he looks up the cañon. The cave was not occupied at the time the studies were made, a passing hunter having wantonly shot one of the birds.

Condors were also found by the Museum expedition up the Agua Blanca, a tributary of the Piru, on one occasion seven of the magnificent birds being in sight at once.

BRANDT'S CORMORANT AT MONTEREY, CALIFORNIA

Background by Charles J. Hittell. Birds by Herbert Lang.

14. BRANDT'S CORMORANT AT MONTEREY, CALIFORNIA

VISITORS to Monterey, California, on the Southern Pacific Railroad who have taken what is known as the "Seventeen-Mile Drive," may recall the rocky islet standing in the Pacific about a quarter of a mile off the coast near Cypress Point. This islet and the Cormorants which each year nest upon it are shown in his group.

Brandt's Cormorant also nests on other islets off our Pacific Coast, and it is a regular visitor to the rocks off the Cliff House at San Francisco, where, however, it does not nest.

Both when flying and when resting upon the water the Cormorant suggests a large duck. The resemblance, however, is superficial, the Cormorant being related to the Pelicans, Gannets, Anhinga and all other birds which have the hind toe connected with the front toes by a web.

The Cormorant is an expert diver and catches its food of fish by pursuing it under water, the hooked bill of the bird doing good service, while the broadly webbed feet propel it at great speed. It is the skill of the Cormorants in fishing that has led both the Chinese and Japanese fishermen to train the birds to act as assistants to them in pursuit of their calling.

The young Cormorant, in common with other members of its order, and unlike the downy young of ducks and geese, is hatched naked and passes more than a month in the nest. The young secure their food by thrusting their heads down the parent's throat. At first sight one might easily imagine that the old bird was trying to swallow its offspring.

When the young bird is a few days old, a thick black down begins to appear on it. Shortly after this coat becomes complete, it is succeeded by the flight plumage. This is dull brownish black, the glossy plumage of maturity being acquired later. As special adornments of the breeding season, both the male and female Cormorants don certain spiny, white nuptial feathers on the back or about the head and neck, while the bare skin of the cheeks and pouch becomes brightly colored. In Brandt's Cormorant, as will be observed, the pouch is rich blue, and the birds appear to distend it for the purpose of display.

Cormorants, like their near relatives, are virtually voiceless, a harsh, rasping call being their only note.

SUMMER BIRD-LIFE OF AN IRRIGATED PORTION OF THE SAN JOAQUIN VALLEY, CALIFORNIA

Background by Charles J. Hittell. Birds mounted by H. C. Denslow.
Birds painted by Louis Agassiz Fuertes.

15. SUMMER BIRD-LIFE OF AN IRRIGATED PORTION OF THE SAN JOAQUIN VALLEY

AT Los Baños, in the San Joaquin Valley of California, the waters of the San Joaquin River are used to flood vast areas to create grazing land for cattle. The region is naturally dry and arid, but irrigation soon transforms the desert into a series of creeks, ponds and marshes. The desert plants are replaced by *Sagittaria*, *Ranunculus*, tulés and cat-tails, and the desert birds give way to a remarkable assemblage of water birds, whose local distribution is governed by the presence or absence of water.

Driving along a levee, which extends as far as the eye can reach, the old and the new life are found to be separated only by the width of the dike. On the left is a parched and sterile plain with Horned Larks, Burrowing Owls, Jack-rabbits, Coyotes, Rattlesnakes and other characteristic desert forms; while on the right are water and fertility, with Ducks, Herons, Ibises, Coots, Stilts, Avocets and other aquatic species in countless numbers.

To the east the view stretches across the desert toward the distant Sierras, where on clear days may be seen the snow fields which, eighty miles away, supply the water at one's feet. To the west (the view represented in the group), one looks over green marshes and shining ponds fairly twinkling with flitting wings, to yellow fields leading up through molded brown foothills to the crests of the Coast Range.

The group contains only the commoner birds of the region—Black-necked Stilts, Avocets, Killdeer, Black and Forster's Terns, Black-crowned Night Herons, White-faced Glossy Ibises, Coots, Mallards, Pintails, Cinnamon Teal, Ruddy and Fulvous Tree Ducks.

While it is true one would not find all these species in a space eight by twenty feet, one could frequently see all or most of them in a single glance, and the impression the group seeks to convey is therefore within the truth.

The sudden changes occasioned by the irregularity of the water-supply are often disastrous to the birds nesting here. The homes of birds which begin to nest before the water has reached its height are sometimes flooded, while the withdrawal of the water deprives the birds of its protection and makes their nests and eggs accessible to marauding animals.

ARCTIC BIRD-LIFE

Little Diomede Island, Bering Strait

16. ARCTIC BIRD LIFE

LITTLE Diomede and Big Diomede form a group of two islands which lie in Bering Sea 50 miles south of the Arctic Circle and about midway between Alaska and Siberia.

The international boundary line passes between them, Big Diomede being Russian and Little Diomede American. The land to the southeast in the central distance of the background is Cape Prince of Wales, a part of the Alaskan mainland distant 23 miles. To the right is Fairway Rock.

The site of the group is the lower part of the 1000-foot cliff at the south end of Little Diomede. Here, protected by isolation, as well as by the nature of their haunts, myriads of Murres, Guillemots, Puffins, Auklets, Gulls and Cormorants come each summer to lay their eggs and rear their young. The Murres nest on rocky shelves, laying highly colored pear-shaped eggs which when moved describe a circle about their tip and thus do not roll off the narrow ledges on which often they are laid.

The Guillemots, Puffins and Auklets lay in crevices and holes; the Gulls and Cormorants build crude nests.

Like many other arctic birds, some of those here shown are widely distributed in boreal waters, and hence are found, or are represented by near relatives, on the eastern side of North America, where Murres, Guillemots, Puffins and Kittiwakes nest as far south as Bird Rock, Gulf of St. Lawrence. A group from that rock is shown at the left of the entrance to this Hall.

A FLAMINGO COLONY IN THE BAHAMAS

Background by L. A. Fuertes (birds) and Charles J. Hittell (landscape). Birds by Herbert Lang

17. A FLAMINGO COLONY IN THE BAHAMAS

BEFORE the studies for this group were made, very little was known about the nesting-habits of Flamingoes. For this reason, and because of the belief that a reproduction of a Flamingo city (beyond question the most remarkable sight in the world of birds) would possess exceptional interest, an expedition was dispatched to the Bahamas in 1902, to find Flamingoes on their nesting grounds. It was unsuccessful; but in 1904 the search was resumed, and on this occasion the birds were discovered, and from an artificial blind, concealed in the very heart of their rookery, containing 2,000 birds, a series of unique photographs and observations was made.

The birds begin to lay their eggs early in May. Their nests are constructed by scooping up mud with the bill and patting it down with bill and feet. The nests are raised to a height of from eight to fourteen inches to protect their contents from a subsequent rise in the water.

Both sexes incubate; one by day the other by night. The young are hatched covered with down, like young ducks. They remain in the nest three or four days and during this period are fed by the parents on predigested juices of a mollusk of the genus *Cerithium*. (See standing bird at the left and also the sitting bird at the right, which is brooding and is about to feed.) They also eat the shell of the egg from which they have so recently emerged.

The singular shape of the bill of the adult Flamingo is related to the manner in which it secures the small spiral *Cerithium* shells which, in the Bahamas, appear to constitute its only food. To obtain them, the bill is pressed into the soft mud until its point turns upward. The lower mandible moves rapidly, forcing out the mud and water through the channels along the sides of the bill and leaving the shells.

It will be noted that the bill of the young Flamingo is essentially straight, but when about two weeks old the curve becomes evident and the young bird begins to feed as does its parent.

When a month old, a second downy plumage is acquired (see bird at right), and at the age of two months, this is replaced by a dress of brownish feathers (see bird at the left). In October or November this is probably followed by the pink plumage of maturity, since no brown birds are seen in the spring.

BOOBIES AND MAN-O'-BIRDS ON CAY VERDE

Background by Bruce Horsfall. Birds by Herbert Lang.

18. THE BOOBY AND THE MAN-O'WAR BIRD IN THE BAHAMAS

CAY VERDE is a coral islet, some forty acres in area, situated about two hundred and thirty miles southeast of Nassau in the Bahamas. Like all reef keys, it is at the junction of a bank with the ocean, and the background clearly shows how sharply the dark blue water, indicating the great depths of the sea, is separated from the lighter water over the shallow banks.

Cay Verde was reached on the "Physalia," a small yacht which the Marine Biological Laboratory of the Carnegie Institution placed at the disposal of the Museum for this occasion. The voyage was begun at Miami, Florida, on March 28, 1907, but unfavorable weather, including a severe storm, in which the "Physalia" narrowly escaped being wrecked, delayed the arrival at Cay Verde until April 8. The Cay has no fresh water, and its only vertebrates are birds, one species of snake and two of lizards.

The Boobies, of which there were about 1500 pairs, nested only on the ground, making little or no nest. They were so tame that one could walk about among the sitting or brooding birds without causing them to leave their eggs or young. As a rule Boobies lay two eggs; but the second is apparently not laid for about a week after the first, and as a rule only one hatches.

The two or three hundred Man-o'-War Birds which lived on Cay Verde placed their nests in the dense growth of "sea-grape" and cactus which covered a portion of the Cay. They lay but one egg. The young acquire a covering of whitish down when a few days old, and this is quickly followed by a surprising development of the feathers of the back, which it will be observed more than cover the back before the corresponding feathers appear in the young Booby.

The male Man-o'-War Bird has the remarkable habit of inflating its red gular or throat-pouch until it resembles a toy balloon. The birds sit on their nests or even fly about displaying this surprising appendage.

With a wing expanse of between seven and eight feet and a body no larger than that of a hen, the Man-o'-War Bird is one of the most powerful and graceful of flyers. It feeds largely on flying-fish, which it catches in the air.

AMERICAN EGRETS IN CUTHBERT ROOKERY

Study for the group from Nature.

CUTHBERT ROOKERY GROUP

Louis Agassiz Fuertes making sketches for the background.

19. A FLORIDA ROOKERY

ROOKERIES" are, or rather were, one of the characteristic features of the bird-life of Florida. The term is generally applied there to all gatherings of roosting or nesting birds, whether Pelicans, Cormorants or Ibises, but, because of their commercial importance, one more frequently hears of Heron rookeries. Before the demand for their plumage had brought the aigrette-bearing Herons and Roseate Spoonbill to the verge of extermination, a Florida rookery was one of the most remarkable sights in the bird-life of our country.

One may still find colonies of Ibises, Cormorants, Pelicans and plumeless Herons, but of those great gatherings of birds which were once so abundant and of which Cuthbert Rookery was a fine example, none now remains. Formerly there could be found the birds just named, and with them were American and Snowy Egrets and Roseate Spoonbills.

As may be imagined, Cuthbert Rookery was situated in the heart of the great mangrove swamp which borders the Everglades at the extreme southern part of the state. So shallow is the water off this part of the Florida coast that the sharpie bearing the Museum expedition, although it drew only two and a half feet, could not approach nearer the shore than seven miles, and five hours were required to reach land by pushing and poling in small boats. In four hours more, following narrow passages through the dense mangroves, Cuthbert Lake was reached. The Rookery was on a small islet, about a mile from the entrance to the lake. At this time (March 29, 1908) it was estimated to contain about 35 Roseate Spoonbills, 15 Snowy Egrets, 350 American Egrets, 50 Little Blue Herons, 2000 Louisiana Herons, several hundred Ibises and a few Cormorants and Water-Turkeys. Only the Spoonbills, Herons and Egrets were nesting.

The group is designed to show a portion of the rookery with the birds nesting and roosting in the mangroves, while the background portrays the whole islet at evening when the birds are returning.

WHISTLING SWAN

Background by Hobart Nichols. Birds by Walter Escherich.

20. WHISTLING SWAN ON SOUTHAMPTON ISLAND, HUDSON BAY

A SWAN on the nest, as shown here, is a conspicuous object, visible far across the arctic tundra, which is the home of this species. The human population is scant, however, and the powerful birds have been known to kill a marauding fox. The nest is built of moss, etc., raked up in the immediate vicinity, and in it are laid two to five white eggs, four and a quarter inches long. Both male and female share the labor of nest-building, of the thirty-five days of incubation, and of caring for the young. The latter are clothed in white down, but this is soon displaced by a grayish plumage, in which the young swans, called cygnets, travel south with their parents in the autumn.

Swans feed chiefly on the grasses and tender water-plants they pull from the bottom, reaching downward with the long neck or, if necessary, tilting the body forward till the tail points toward the sky, after the fashion of the common domestic duck and related species. They cannot dive for food as do so many ducks. Small mollusks are also eaten.

Swans are famous for their loud, clear voices, resembling trumpets, horns or other wind instruments.

The Whistling Swan breeds in arctic Alaska and Canada east to Hudson Bay. In winter it is not uncommon locally on the Atlantic Coast south from Maryland and along the Mississippi Valley, Gulf Coast and Pacific Coast. Here in the Northeast it is only a rare migrant, and anyone is very fortunate who ever sees a high-flying flock and hears the far-reaching, clarion calls.

The only other swan in North America is the Trumpeter, now very rare. It is an even larger bird and lacks the yellow spot in front of the eye.

WHOOPING CRANE

Background by Hobart Nichols. Birds mounted by Walter Escherich.
Birds in background by Louis Agassiz Fuertes.

21. WHOOPING CRANE

THE Whooping Crane is one of the largest of North American birds and the stateliest. It has been sent down the same road as have so many conspicuously fine species, and now seems on the verge of extinction, for it is rare even in its restricted breeding range and unknown on the Atlantic Coast, where it formerly occurred as a transient. It winters from the Gulf States to central Mexico.

In December, 1811, on the Mississippi, Nuttall witnessed a migration of this species, assembled in a "mighty host. Their flight took place in the night, down the great aërial valley of the river. * * * The clangor of these numerous legions passing along high in the air seemed almost deafening * * * and as the vocal call continued nearly throughout the whole night without intermission, some idea may be formed of the immensity of the numbers now assembled on their annual journey to the regions of the South."

The important differences between Cranes and Herons are noted in the description of the Sandhill Crane group on the opposite side of this gallery. Like other cranes, the Whooping has an elaborate courtship dance, nests on the ground in open country, is nearly omnivorous, and possesses a far-reaching, clarion voice.

The scene here shown is in the autumn on Heron Lake, Minnesota, where thousands of Canvasbacks, Gulls and other waterfowl congregated, and the Whooping Crane doubtless once nested. The brown and white bird is a young one. One of the adults is trumpeting to the flock passing overhead.

A GOLDEN EAGLE'S NEST IN BATES HOLE, WYOMING

Photograph from Nature of the scene reproduced in the group.

22. THE GOLDEN EAGLE IN WYOMING

THE Golden Eagle ranges throughout the mountainous parts of the Northern Hemisphere. In North America it is now very rare east of the Rocky Mountains, but from the Rockies west to the Pacific, and north to Alaska, it is not uncommon. In the mountains, the bird nests on cliffs, but in California it often builds in trees, white oaks being frequently chosen.

Although the Golden Eagle is powerful enough to prove a dangerous antagonist, it never attacks man, in spite of sensational stories to the contrary. Even when its nest is approached, the bird makes no attempt to protect its young, but either disappears entirely, or, calling, circles high in the air.

Eagles, like most raptorial birds, nest early in the year. They usually lay but two eggs, which hatch after thirty-five days' incubation. The young remain in the nest about two months. The natural food of the Golden Eagle in the west consists chiefly of small mammals of various kinds, such as prairie dogs, rabbits, squirrels, spermophiles and rats, together with ducks, geese and grouse. Occasionally it takes a young deer or antelope. On the whole, however, under natural conditions, the Golden Eagle is a beneficial bird because of the large number of rodents it destroys. But where sheep have been introduced, the Golden Eagle may become more or less injurious through its acquired habit of preying on lambs.

Four species of Eagles have been recorded from America north of Mexico. Of these the Gray Sea Eagle, an Old World species, is found in this hemisphere only in Alaska; and the Harpy Eagle, a tropical species, has been recorded but once, from Texas. This leaves virtually only two North American species, the Golden and the Bald Eagle. When the Bald Eagle is mature, with a white head and tail, the two species are very unlike in color, but before the Bald Eagle acquires its distinctive marks, it bears a general resemblance to the Golden Eagle. The latter, however, has the legs feathered to the toes, while in the former the lower part of the "legs" (tarsi) is bare.

A KLAMATH LAKE BIRD COLONY

Background by Charles J. Hittell. Birds by Herbert Lang.

23. KLAMATH LAKE BIRD-LIFE

KLAMATH LAKE is situated in northeastern California on the Oregon boundary line. Its shallow water permits a great growth of tulés, or rushes, which almost completely fringe the shore, in places expanding to a width of several miles. They also form islands varying in size from a few square yards to many acres in extent. It is on these islands that the bird colonies are established. There is no soil or beach, and all the birds nest on the beds of matted tulés, usually at the border of the island. The White Pelicans, therefore, find here no pebbles with which to construct their usual mound-like nests; the Caspian Terns do without sand, and the Cormorants without rocks. Far more important than these is the protection which ground-nesting communal birds require, and this the islands supply.

Fifteen colonies of White Pelicans were counted in this locality between June 30 and July 7, 1906, and doubtless there were others, since only a part of the bird-inhabited region was examined. There were also great numbers of California and Ring-billed Gulls, Caspian Terns and Farallon Cormorants, while Great Blue Herons, in default of trees, built platform nests of tulés among the growing reeds. White Pelicans feed while swimming, and were here devouring diseased fish which were floating in the water in large numbers, while Brown Pelicans capture their prey by diving; but the young of both species make their first attempts at fishing down the parental pouch, as a comparison of this group with the one of the Brown Pelican on the opposite side of the hall will show. The White Pelican weighs sixteen pounds, twice as much as the Brown Pelican. Its wing expanse is between eight and nine feet, and, when in the air, it is one of the most impressive of birds.

The group represents the border of a tulé island, while the background shows other bird-inhabited islets, the surrounding treeless hills, and Mount Shasta in the distance. Since it was made, a land reclamation project has robbed this area of its water and a dusty bottom has now replaced the lake. The birds, deprived of their homes, have been forced to seek asylum elsewhere. Our studies were made none to soon.

ARCTIC-ALPINE BIRD-LIFE IN THE CANADIAN ROCKIES

Background by Carl Rungius from a sketch by L. A. Fuertes. Birds by Herbert Lang.

24. ARCTIC-ALPINE BIRD-LIFE OF THE ROCKY MOUNTAINS

WHERE the summits of the Rocky Mountains, Sierras and Cascade Range reach above timber-line to the limits of perpetual snow, the boreal nature of the climate produces conditions favorable for the existence of many plants and animals which, in the Arctic Regions, are found at sea-level. The altitude at which these conditions appear decreases as the latitude increases. For example, in Colorado, at latitude 40°, timber-line is at 11,000 feet altitude, while Alberta, Canada, at latitude 50°, timber-line is at about 7,500 feet.

Where the area of sufficient altitude is practically continuous, the presence of arctic forms of life may be due to extension of range southward; but where it is discontinuous, a boreal area may be separated from a similar region to the north by intervening lower ground, when the occurrence of boreal forms may be attributed to the influence of the Glacial Period. Forced southward during the Ice Age, they were left stranded on these high Arctic-Alpine islands as the ice receded.

The characteristic Arctic-Alpine birds of our western mountains are the White-tailed Ptarmigan, the Rosy Snow Finch (*Leucosticte*) and the Pipit. In the Rockies they are found as far south as Colorado or New Mexico. The Pipit migrates southward in winter, but the Ptarmigan and Snow Finch are practically permanent residents, in winter descending only slightly below timber-line. At this season, as is well known, the Ptarmigan acquires a pure white plumage. (For a seasonal group of Ptarmigan and an explanation of their plumage changes, see the Main Bird Hall.)

The studies for this group were made in the Canadian Rockies about fifteen miles north of Laggan at the Ptarmigan Lakes. The party outfitted at Lake Louise, and ascended the mountains to the northward, from which one obtains a beautiful and impressive view. At the left, beyond Mount Redoubt, in the foreground, lie the peaks of Moraine Lake; in the center is Mount Temple; and to the right, Hungabee, Lefroy and Victoria.

At this season (July 15, 1907) the alpine spring was at its height. The lakes were opening; great white anemones were blooming at the border of the snowfields; the heather was white with little bell-like flowers, and the beds of fluted *Dryas* leaves were starred with blossoms.

SAGE GROUSE IN WYOMING

Background by Charles H. Hittell. Birds by Herbert Lang.

25. THE SAGE GROUSE IN WYOMING

NEXT to the Wild Turkey, the Sage Grouse is the largest of North American game birds. Its range is restricted to the high, sagebrush (*Artemisia tridentata*) plains of the West, from western Nebraska and western Dakota north to, and in places slightly beyond, the Canadian boundary, west to eastern Oregon and northeastern California, east of the Sierras, and south through Utah and Nevada.

Within these limits the Sage Grouse is resident, but it migrates locally at the approach of winter from higher to lower altitudes, as the snows deprive it of its food. This consists largely of the leaves of the sagebrush, but in summer the leaves and seeds of other plants are eaten. When feeding on sagebrush leaves, the flesh of the old bird is flavored by the nature of their food, but the birds of the year are very palatable.

The Sage Grouse begins to mate very early in the spring, or, in some localities, as soon as late February, and at this season the males indulge in the most remarkable performances, inflating the yellow sacs at either side of the neck, spreading the tail, dropping the wings and strutting like a turkey cock.

The nest is a slight affair, usually placed beneath sagebrush, where it is often found by a marauding coyote. The hens hatch the eggs and raise the young unaided by the male, which, when its mate begins to sit, joins with others of its sex to form flocks composed only of males.

When the young are grown the sexes mingle in great bands, which formerly contained thousands of birds. The birds drink night and morning at some regularly frequented spring, about which they sometimes gather so thickly that they must await their turn to reach the water.

This fine grouse is rapidly decreasing in numbers and unless adequately protected will ere long be numbered among the lost species.

The studies for this group were made at Medicine Bow, Wyoming, on the line of the Union Pacific Railway. The mountain to the right is Elk Mountain; those in the distance belong to the Snowy Range of Colorado.

THE LOVE-MAKING OF THE PRAIRIE HEN

Background by Bruce Horsfall. Birds by H. C. Denslow.

26. THE PRAIRIE HEN IN NEBRASKA

ON frosty spring mornings, as the sun rises over the prairies, one may at times hear a singular, resonant, booming note, *boom-ah-b-o-o-m*, *boom-ah-b-o-o-m*. It is the love-song of the Prairie Hen. He may be near at hand or possibly two miles away, so far does this sound, unobstructed by tree or hill, carry in the clear air. It is well worth following, for we may find the maker of it, with perhaps ten to fifty of his kind, engaged in a most remarkable performance.

During the mating season, from March until early in May, the Prairie Hens of a certain district or area gather before daybreak to take part in these courtship demonstrations. The feather-tufts on either side of the neck are erected like horns, the tail raised and spread, the wings dropped, when the bird first rushes forward a few steps, pauses, inflates its orange-like air-sacs, and, with a violent, jerking, muscular effort, produces the startling boom, which we may have heard when two miles distant.

At other times, with a low cackle, he springs suddenly into the air, as though quite unable to control himself, and finally he comes within striking distance of a rival who has been giving a similar exhibition. Then, with much clashing of wings, a fight ensues which often strews the nearby grass with feathers.

These tournaments of display and combat are doubtless designed to arouse the attention of the females, but they also occur when only males are present. Within an hour or two after sunrise, the time varying with the ardor of the birds, the competition is over for the day and the rivals feed peacefully together, until they enter the lists the following morning.

Market hunting has greatly decreased the numbers of Prairie Hens, but on the United States Government Forest Reservation, in the sparsely inhabited sandhills of western Nebraska, on the line of the Chicago, Burlington and Quincy Railroad, where the studies for this group were made, they still exist.

The eastern Prairie Chicken, or Heath Hen, was once locally common from New Jersey to Massachusetts; until 1929 it was found on Martha's Vineyard but it is now extinct.

THE LOVE-MAKING OF THE PRAIRIE HEN

Background by Bruce Horsfall. Birds by H. C. Denslow.

26. THE PRAIRIE HEN IN NEBRASKA

ON frosty spring mornings, as the sun rises over the prairies, one may at times hear a singular, resonant, booming note, *boom-ah-b-o-o-m, boom-ah-b-o-o-m.* It is the love-song of the Prairie Hen. He may be near at hand or possibly two miles away, so far does this sound, unobstructed by tree or hill, carry in the clear air. It is well worth following, for we may find the maker of it, with perhaps ten to fifty of his kind, engaged in a most remarkable performance.

During the mating season, from March until early in May, the Prairie Hens of a certain district or area gather before daybreak to take part in these courtship demonstrations. The feather-tufts on either side of the neck are erected like horns, the tail raised and spread, the wings dropped, when the bird first rushes forward a few steps, pauses, inflates its orange-like air-sacs, and, with a violent, jerking, muscular effort, produces the startling boom, which we may have heard when two miles distant.

At other times, with a low cackle, he springs suddenly into the air, as though quite unable to control himself, and finally he comes within striking distance of a rival who has been giving a similar exhibition. Then, with much clashing of wings, a fight ensues which often strews the nearby grass with feathers.

These tournaments of display and combat are doubtless designed to arouse the attention of the females, but they also occur when only males are present. Within an hour or two after sunrise, the time varying with the ardor of the birds, the competition is over for the day and the rivals feed peacefully together, until they enter the lists the following morning.

Market hunting has greatly decreased the numbers of Prairie Hens, but on the United States Government Forest Reservation, in the sparsely inhabited sandhills of western Nebraska, on the line of the Chicago, Burlington and Quincy Railroad, where the studies for this group were made, they still exist.

The eastern Prairie Chicken, or Heath Hen, was once locally common from New Jersey to Massachusetts; until 1929 it was found on Martha's Vineyard but it is now extinct.

GREBES (Upper Figure) and **WILD GOOSE** (Lower Figure) on Crane Lake, Saskatchewan

Backgrounds by Hobart Nichols. Birds mounted by Herbert Lang.
Birds painted by Louis Agassiz Fuertes.

27. THE WILD GOOSE AND (28) GREBE GROUPS

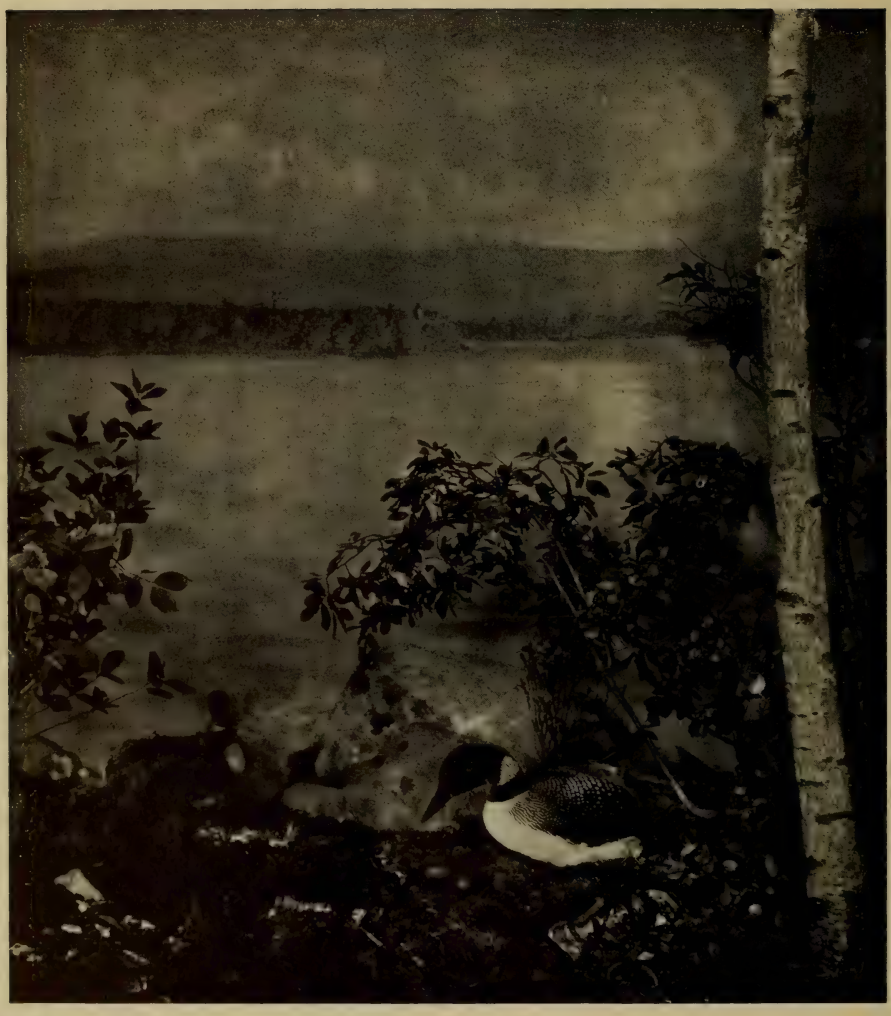
TWENTY-FIVE years ago the lakes and sloughs of our more northern plains and prairies were the breeding homes of vast numbers of wildfowl of many species, but the demands of agriculture have forced the birds to find new haunts north of the Canadian boundary. There, too, if proper protection is not accorded them, they will again be dispossessed by the advance of civilization.

Crane Lake, Saskatchewan, near the line of the Canadian Pacific, where the studies for both the Goose and Grebe groups were made, is typical of many similar resorts of wildfowl in western Canada. In the vicinity of and about the border of sloughs and lakes, there nest Willets, Marbled Godwits, Long-billed Curlew, Killdeer, Avocets, Wilson's Phalaropes, Shovelers, Gadwalls, Mallards, Pintails and Blue-winged Teal; while among the reeds and tulés Western and Eared Grebes, Franklin's Gulls, Black Terns, Redhead and Canvasback Ducks, Ruddy Ducks and Coots build their homes. The Geese resort to islands where also Ring-billed and California Gulls, Common Terns and Pelicans are found. Favorable islands are also selected by Ducks, and on the island shown at the right in the background of the Grebe group, Messrs. Bent and Job estimated that on June 17, 1905, "at least 150 pairs of Ducks were breeding or preparing to breed."

The Wild Geese arrive from the south before the ice leaves the lakes, and lay their eggs early in May. The young birds in the group were taken on June 15, 1907, when they were about two weeks old. Grebes' nests are mere platforms of water-soaked vegetation. These eminently aquatic birds walk with difficulty and their homes must therefore be near the water. They leave the nest at the slightest alarm, but usually first cover their eggs with a part of the nesting material. One of the birds is shown in this act.

The young swim soon after hatching and for a time are carried on the back of the parent.

The background in both groups shows the rolling, treeless plains with, in the Goose group, a line of dune-like sandhills, where, among the low bushes, Sharp-tail Grouse are found.



LOON ON LAKE UMBAGOG

Background by Hobart Nichols. Birds by Jenness Richardson.

29. LOON; GREAT NORTHERN DIVER

LOONS, like Grebes, are among the most aquatic of birds. All their feeding is done in the water, and their nests are always so placed that the sitting bird can slide quickly into and under the water. They live almost entirely upon fish. These they chase under water, swimming for the most part with the feet alone. Baby Loons hatch covered with dense, dusky down, and can swim almost at once. While many Loons spend the winter along shore, often fishing close to the beach, more keep far out, even fifty miles or more from land all the season. When one does come out on land, both bill and wings are used to help the unaccustomed feet.

Though wintering on salt water, the Loon nests largely on the fresh-water lakes of the North in scattered pairs. There may be heard its wild cry, "one clear, piercing note or a long, quavering, demoniacal laugh, that to the timid suggests a herd of screaming panthers. It is one of the stirring, inspiring sounds in nature." In winter the birds are silent and dressed quietly in brownish-gray above and white below.

This species breeds in the northern part of North America, Europe and Asia, and winters from about the southern edge of its breeding range to southern Lower California, the Gulf Coast, Florida, the Mediterranean Sea and China.

BIRD ROCK

The First of the Habitat Bird Groups in the American Museum

Key to the Bird Rock Group

1, Common Murre. 2, Brünnich's Murre, 3, Razor-billed Auk. 4, Kittiwake Gull. 5, Gannet. 6, Puffin. 7, Leach's Petrel

30. THE BIRD ROCK GROUP

A Study of an Island Colony

TO the preserving influence of island-life we owe the continued extistence of many birds that have long ceased to live, or, at least, to nest, on the mainland. In every instance, however, whether the island be a thousand square miles or one square foot (as a Grebe's floating nest) in extent, it owes the preservation of its bird-life to the same cause—the entire or comparative absence of bird enemies, terrestrial mammals in particular.

Bird Rock, with its neighbor, Little Bird Rock, belongs to the Magdalen Group in the Gulf of St. Lawrence. It is 351 yards long, from 50 to 140 yards wide, and rises abruptly from the sea to a height of from 80 to 140 feet. Its vertical rocky walls are weathered into innumerable ridges, shelves and crevices—fit sites for the nests of the sea-birds that for centuries have made the Rock their home. The birds, furthermore, have found an abundance of food (chiefly fish) in the surrounding waters.

The Bird Rock Group was not definitely planned as a "habitat group," but rather as a picture of part of a famous and impressive bird colony and a permanent record of a characteristic phase of island-life.

The material for the group was collected in July, 1898, and for many years the group marked the highest point reached in the presentation of bird-life. It includes examples of the various species that breed—one can hardly say nest—on the rock, the most noteworthy and noticeable being the great white Gannets. Then come the Murres, Razorbills and Puffins, the graceful Kittiwake, and, last and least, Leach's Petrel, seldom seen because it nests in little burrows like rat-holes and comes and goes at night.

The Bird Rocks are of interest alike to naturalist and historian, for their story begins with the discovery of these little islets by Jacques Cartier in June, 1534. He records his visit as follows: "These islands were as full of birds as any meadow is of grass, which there do make their nests, and in the greatest of them there was a great and infinite number of that that we called Margaulx that are white and bigger than any geese, which were severed in one part. In the other were only Godetz and Great Apponatz, like to those of that island that we above have mentioned. We went down to the lowest part of the least islands, where we killed above a thousand of those Godetz and Apponatz. We put into our boats as many as we pleased, for in less than an hour we might have filled thirty such boats of them. We named them the islands of the Margaulx."

Three centuries later, Audubon, whose energy in exploration no ornithologist has ever surpassed, visited this colony and was duly impressed with its wonders, though the freshening wind prevented him from landing on the rock itself.

Then evil days fell upon this bird metropolis; fishermen commenced to visit it to obtain birds and eggs for food and birds for bait; a lighthouse was erected and, within ten years, the Gannet population of 100,000, which, seen from a distance, had caused Audubon to think that this rock was covered with snow, was swept from the top of the rock. To-day, though still one of the ornithological wonders of our Atlantic coast, the colony is but a shadow of its former self. Fortunately, in March, 1919, the Rock was made a bird sanctuary by the Canadian Parliament and under protection its feathered population is secure.

BIRD ROCK FROM THE SOUTHWEST

Distance about one-half mile

(From "Bird Studies with a Camera," by permission of D. Appleton & Co.)

CAMP ON CAY VERDE, BAHAMAS

CAMP ON CAY VERDE, BAHAMAS

FOR THE PEOPLE

FOR EDUCATION

FOR SCIENCE

HUDSON-FULTON CELEBRATION COMMISSION

AMERICAN MUSEUM OF NATURAL HISTORY

The Indians of Manhattan Island and Vicinity

AN INDIAN ROCK HOUSE IN GREATER NEW YORK

By ALANSON SKINNER

Department of Anthropology

GUIDE LEAFLET NO. 29

SEPTEMBER, 1909

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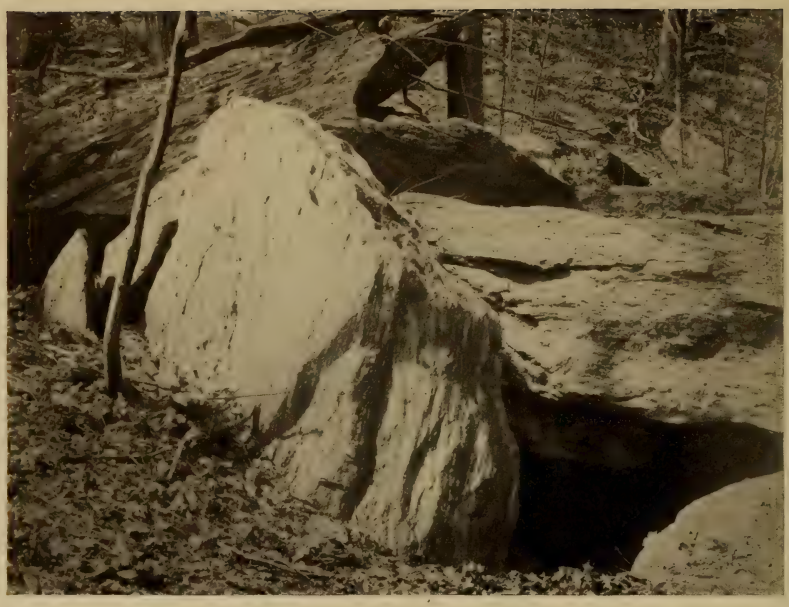


FIG. 1. INWOOD ROCK-SHELTER, MANHATTAN.

FIG. 2. FINCH'S ROCK HOUSE.

The Indians of Manhattan Island and Vicinity

A GUIDE TO THE

SPECIAL EXHIBITION

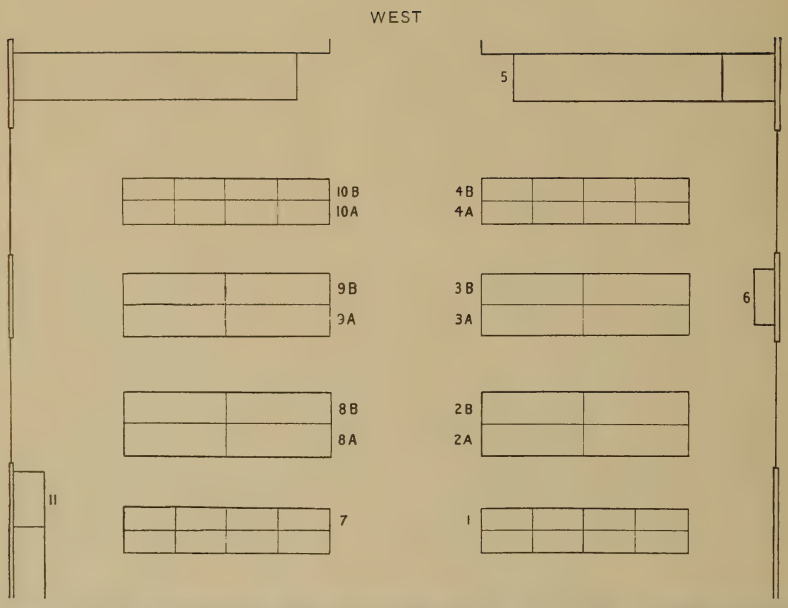
AT THE

AMERICAN MUSEUM OF NATURAL HISTORY

PREPARED FOR THE

HUDSON-FULTON CELEBRATION COMMISSION

BY THE MUSEUM



FLOOR PLAN, WESTERN END OF THE HALL OF THE PLAINS INDIANS (No. 102).

EXPLANATION OF CASE NUMBERS.

1 Mohegan and Delaware. Iroquois: Clothing; Weapons.
2A Prehistoric Life in Greater New York.
2B Prehistoric Manhattan Island.
3A Shinnecock Hills, Long Island.
3B Van Cortlandt Park. Long Island.
4A Iroquois: Corn Food; Household Utensils.
4B Iroquois: Transportation; Games; Ceremonial Objects; Wampum.
5 Iroquois Group.
6 Shell Heap.
7 Iroquois: False Face Society.
8A Westchester County.
8B Upper Hudson.
9A Kah Kwah and Erie Indians of New York State.
9B New York State. Articles of European Manufacture.
10A Pottery of Greater New York. Husk Face Society.
10B Bolton and Calver Collection.
11 Rock Shelter.

NO. 29

OF THE GUIDE LEAFLET SERIES OF THE
AMERICAN MUSEUM OF NATURAL HISTORY
EDMUND OTIS HOVEY, EDITOR
New York. Published by the Museum. September, 1909

THE INDIANS OF MANHATTAN ISLAND AND VICINITY.

By Alanson Skinner,
Department of Anthropology.

Introduction.

As a part of the Hudson-Fulton celebration, a special exhibit representing the Indians of New York has been arranged in the West Hall, on the ground floor of the Museum. The low, or table cases, contain implements of stone, bone, shell and other materials, found on Manhattan Island and in and around Greater New York,— implements once used by the Indians occupying this region. In the upright cases will be found ethnological objects, many of which are still in use among the surviving Iroquois Indians of New York State. This guide, therefore, refers chiefly to the remains of Indians found upon Manhattan Island and adjacent shores, examples of which are shown in the table cases. The location of the various cases may be seen from the accompanying plan.

In using this guide, the visitor is advised to turn north, as he enters the exhibit and take a general view of the cases in the order designated; then it is suggested that he follow the discussion (pp. 14–36) of the various kinds of specimens found near New York City as he makes a second examination of the exhibits in the table cases.

The Hudson-Fulton exhibition is designed to show the life of the Indians of New York City and vicinity in prehistoric times, when primitive conditions were as yet unchanged by the advent of European settlers. The objects shown have been collected by Museum expeditions sent for the purpose of excavating the ancient village, camp and burial sites of the Indians in several localities within the area indicated, and the exhibits have been prepared from the remains thus secured. The remnants of the tribes that once occupied the primeval forests of Greater New York have so long been scattered and lost that almost nothing can be obtained from them now.

Beginning with the northern half of the exhibit, the visitor will find the first section of the upright case (1)[1] devoted to a few specimens showing some of the more perishable articles formerly in use among the Delaware and Mohegan Indians of this immediate vicinity. Most of these have been collected from the scattered remnants of these people, or else were obtained from old families who, since the disappearance of the natives, preserved

[1] See diagram on page 4.

of things below the sod is to test with a spade or a crowbar. If shells are present, their crunching soon gives notice of the fact. Sometimes shell heaps have been located by shells thrown from mole and woodchuck burrows, or by outcropping in gullies washed by the rain, or banks broken down by the surf. They are generally located near some creek or bay on low but dry ground, preferably with an eastern or southern exposure, and, as before mentioned, not far from drinking water. Some have been found fronting on the open Sound, but such cases are rare. These deposits consist of large quantities of decayed oyster, clam and other marine shells mixed with stained earth, with here and there ashes, charcoal and fire-broken stones to mark the spots where ancient camp fires blazed. Among

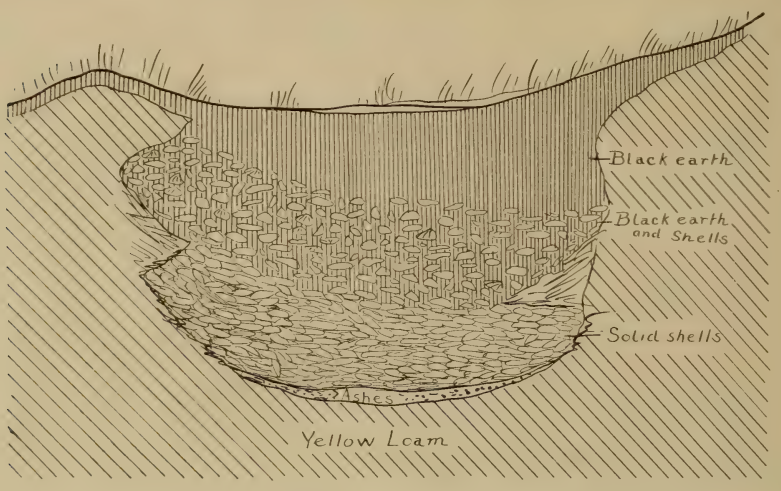


FIG. 4. CROSS SECTION OF A SHELL PIT.

the shells are usually scattered antlers of deer, fish bones, bones of animals and birds split for the marrow, quantities of pottery fragments, and broken implements, in short, the imperishable part of the camp refuse left by the Indians. Now and then, perfect implements and ornaments that had been carelessly lost in the rubbish or hidden for safe-keeping are discovered. Little did the Indian think, as he laid away his little hoard, that his handiwork would never see light again until he and his people had long been gone and forgotten.

Shell heaps vary from a few inches to four feet in depth, and in area from a few square yards to several acres — all depending on the length of time the settlement was occupied and the number of dwellings comprising it. Deep shell heaps are often divided into layers, the lowest of which are, of

course, the oldest. Under and near most of these deposits may be found scattered "pits" or fire holes, which are bowl-shaped depressions in the ground filled with layers of stained earth, shells and other refuse, with an occasional layer of ashes. Some pits are as large as ten feet wide by six feet deep, but the average is four feet deep by three feet wide. It is supposed that they were used as ovens or steaming holes and afterwards filled up with refuse (Fig. 4). Some contain human skeletons, which may have been interred in them during the winter season when grave digging was impossi-

FIG. 5. MAP GIVING THE LOCATIONS OF SHELL DEPOSITS.
Those marked + have been explored by the Museum.

ble. Pits as a rule, contain more of interest than the ordinary shell layer. The closely packed regular masses of shells form a covering which tends to preserve bone implements, charred corn and such perishable articles from decay in a way that the looser shells of the general layers fail to do.

Shell heaps, while abundant along the seacoast, are seldom found inland, except on salt creeks or other streams having access to salt water. They may be seen all along the east shore of the Hudson River at more or less

frequent intervals up as far as Peekskill, and on Croton Point and between Nyack and Hook Mountain on the west shore they attain considerable size. There are a few small deposits, however, composed mainly of brook clams (Unio) situated on fresh water lakes in the interior of Westchester County. There are many shell heaps on Staten Island. Shell heaps occur or did occur on Constable Hook, New Jersey, and at intervals between there and Jersey City along the western shore of New York Bay. The accompanying map (Fig. 5) gives the location of the important known shell deposits of the vicinity of New York City.

FIG. 6. GRAVE OF SKELETONS WITH ARROW POINTS.

On the opposite side (4B) of the upright case, the Iroquois exhibition is continued, but the last section is devoted to a small exhibit showing the manufacture of wampum by the Indians of Long Island with prehistoric implements and a number of specimens of wampum belts and strings collected from the Iroquois of New York and Canada.

The wall case (5) at the western end of the room contains a group illustrating the costumes of the Iroquois Indians of a period from about 1790 to the present day.

Beginning on the south side of the aisle, the easternmost upright case

(7) is devoted to the False Face Society of the Iroquois, while the table case (8A) immediately following contains objects from Westchester County and Staten Island. In these sections an interesting feature of aboriginal life is shown. Although most of the Indians of the vicinity of Greater New York did not place objects in the graves with their dead, some graves at Burial Ridge, Tottenville, Staten Island, when opened for the Museum in 1895, were found to contain a great many interesting and valuable remains. With the skeleton of a child there was a great deposit of utensils, both finished and unfinished ornaments, such as beads, pendants, and the like, a stone pipe and a number of other objects, while not far away the skeletons of three Indian warriors were exhumed (Fig. 6), in and among whose bones there were found, as shown in this section, twenty-three arrow points of stone, antler and bone (Fig. 7).

This is an excellent exhibit indicating the use of the bow in Indian warfare. The skeletons lay side by side with the legs flexed as shown in the illustration (Fig. 6). In the first skeleton, it was found that two points of antler and one of bone had pierced the body and lodged near the spinal column. Another point of argillite had been driven between two ribs, forming a notch in each. A bone arrow point had struck the shoulder and was resting against the scapula. Among the bones of the right hand, an arrow point of antler was discovered, and there was a similar one near the left hand. Another antler point was lying in the sand just beneath the body and had, no doubt, dropped from it when the flesh wasted away. The most interesting wound of all was one where an antler-tipped arrow had ploughed through one side of the body and fully one-third of the point had passed through one of the ribs, making a hole, where it remained, as smoothly as if drilled. The second body was also terribly injured. The left femur showed an elongated puncture near the lower end, probably made by an arrow point. Among the ribs was the tip of an antler point, and a yellow jasper one was among the ribs on the left side of the body. Three other points were among the bones. The third skeleton was likewise an example of old-time bow play. There was an antler point among the ribs on the left side. The end of one of the fibulæ was shattered by a stone arrow point, and a second point had lodged between two ribs. Beneath the sternum was a flint point, and the right shoulder blade showed a fracture near the end, caused by a blow of some hand implement or an arrow. Near the base of the skull, the end of an antler arrow point was discovered, broken perhaps by its impact with the occiput. Two bone points were near the lower bones of the left leg. A second point was found upon search among the left ribs; under the vertebræ was the base of another antler point, and two broken points were found beneath the body.

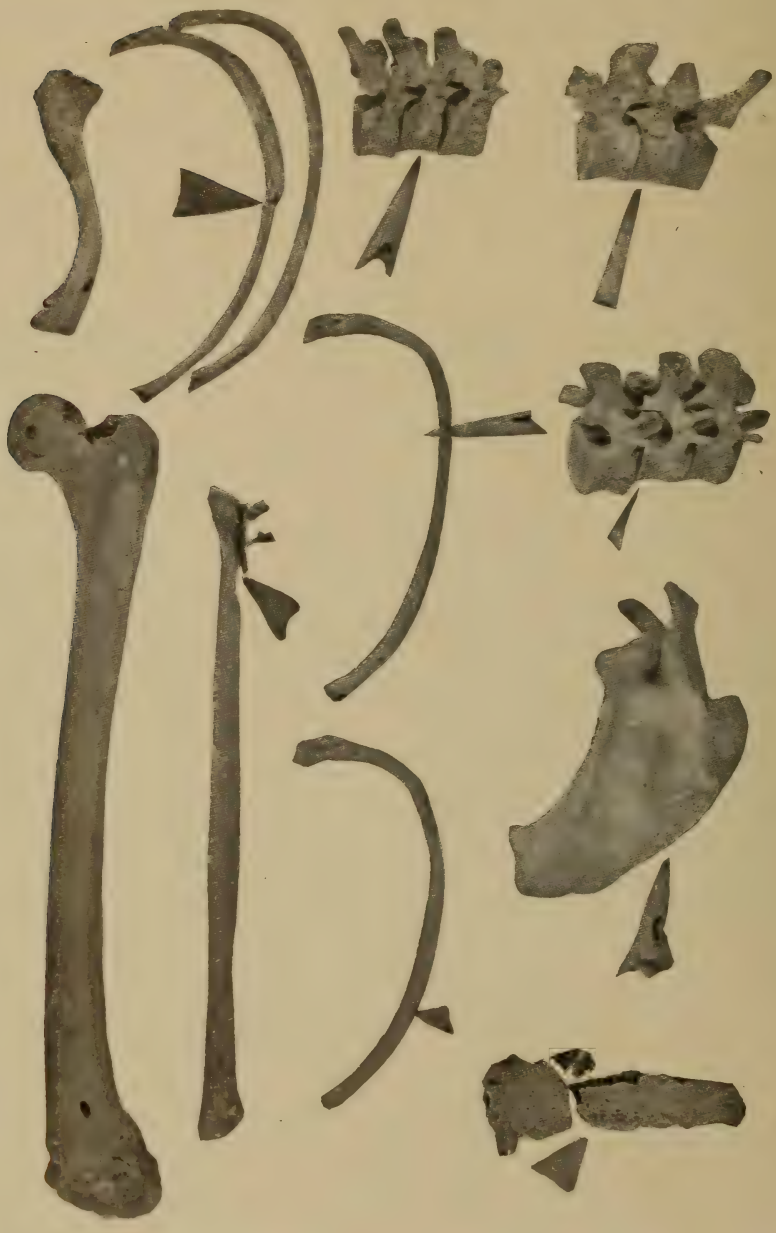


FIG. 7. BONES PUNCTURED BY ARROW POINTS, FROM SKELETONS FOUND ON STATEN ISLAND.

The position in which several of the points were found certainly speaks well for the great force which propelled them. The long bows of the local Indians must indeed have been formidable weapons. Taking into consideration the number of arrows which must have been imbedded in the bodies of the warriors, it is perhaps probable that the majority of the projectiles were driven into the victims at close range after death.

In the wall case (11) south of the exhibit will be found the model of a rock-shelter and typical objects found in such places. These, as the name implies, are protected spots in rocky ledges, where Indians once made more or less permanent places of abode. Many such shelters exist in the vicinity of New York, one or two having been discovered at Inwood, Manhattan (Fig. 1). The most important rock-shelter so far discovered is the so-called

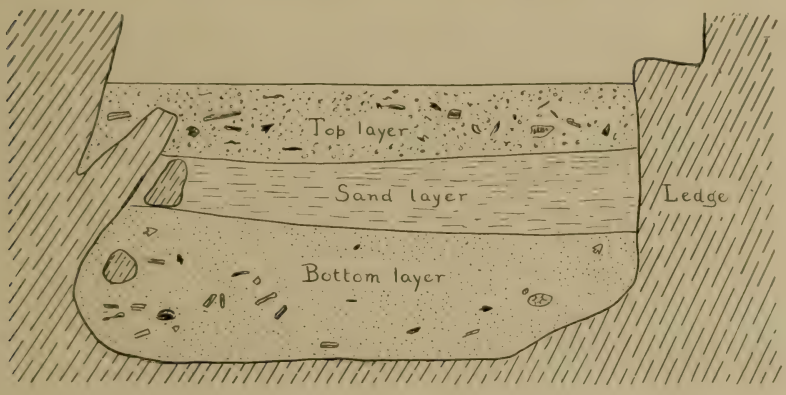


FIG. 8. VERTICAL SECTION OF REFUSE IN FINCH'S ROCK HOUSE, ABOUT MIDWAY OF THE CAVE

Finch House (Fig. 2) reproduced in the model. The original is near Armonk, Westchester County, New York. One point of special interest is the fact that the Finch shelter contained two layers bearing relics separated by sand as shown in the drawing (Fig. 8). As no pottery was found in the bottom layer, it has been inferred that we have here the remains of two different races of Indians, the older not yet advanced to the pottery-making stage. This conclusion, is, however, far from final, for the whole arrangement may be due to accident.

The table case 8B contains objects selected from the Henry Booth collection illustrating the life of the Indians of the Upper Hudson. They are especially interesting on account of the number of ceremonial "banner stones" found in that region, which are apparently not nearly so abundant anywhere else in this vicinity.

In the next table case the section 9A is devoted to the life history of some of the Iroquois tribes other than the Five Nations of western New York, and the following section (9B) shows, as well as possible, the culture of the Iroquois Indians of central New York and objects used by the Indians of New York State in general manufacture or obtained from the Europeans upon the advent of the settlers. In the upright case (10A) there is presented an exhibition of pottery vessels, all but one of which were found within the limits of Greater New York, and some implements from the Iroquois of the Mohawk Valley, besides material illustrating the societies of the Iroquois. On the other side, (10B), the entire case is filled with specimens from the Bolton and Calver collection from Manhattan Island, which will be more fully described below.

The Types of Indian Relics found in and about New York City.

Having now taken a general view of the exhibit, the visitor may be interested in a study of the several kinds of relics found in this locality. As these types are somewhat different from those found in near-by regions, we conclude that the Indians formerly living here had habits and customs different from those of their neighbors. For want of a better name, these long-extinct tribes have been called the New York Coastal Algonkin. The term Algonkin designates the language they spoke, while the adjective defines their habitat.

In the term New York Coastal Algonkin, the writer includes the tribes along the coast from Tottenville, Staten Island, the extreme southern point of the state, to the Connecticut boundary on Long Island Sound, including to a certain extent the shores of New Jersey immediately adjacent to Staten and Manhattan Islands, the east bank of the Hudson River as far north as Yonkers, and exclusive of Long Island except the western end. From the examination of the remains of the New York Coastal Algonkin area preserved in many collections, both public and private, it becomes obvious that the objects found may be roughly divided into three groups: articles of stone, articles of bone and antler, and articles of clay, shell and metal. The first group is, from the imperishable nature of its representatives, naturally the largest and comprises a number of sub-groups to be briefly described and commented upon in this paper. Examples of this type will be found in the table cases previously mentioned. For the following descriptions and historical notes the author has largely drawn on Mr. James K. Finch's and his own contributions to Volume III of the "Anthropological Papers of the American Museum of Natural History" (New York, 1909).

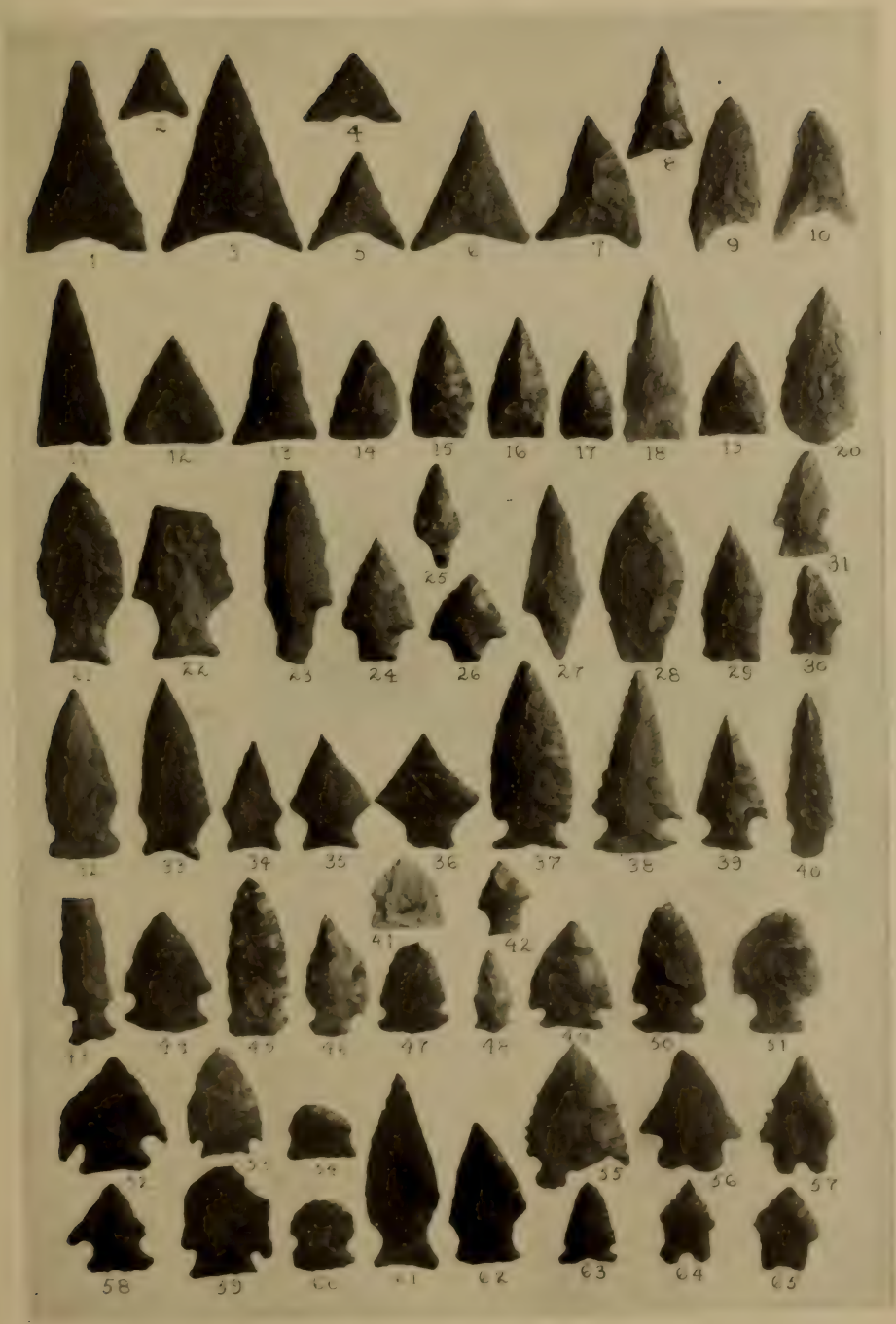


FIG 9. TYPES OF ARROW POINTS

Chipped Articles.

Arrow Points (Fig. 9). Two general types may be recognized, and these are the stemmed or notched, and the triangular forms. The former are by far the most abundant, and while these are usually made of the nearest local rock possessing the necessary conchoidal fracture, in some cases they are of material brought from a long distance. Specimens made of pink flint resembling stone from the Flint Ridge of Ohio, and of jasper found to the south of this region have been recorded. Blunt arrow points are rare, the Indians probably preferring wooden arrows for this type. Many of the so-called "blunt-points" found in collections, appear to be scrapers made over from broken arrow points of a large size.

The triangular type has long been regarded by the local collectors of this vicinity as being the type used in war, the argument being that as it has no stem, it was necessarily but loosely fastened in its shaft and, if shot into the body, would be very liable to become detached and remain in the flesh if any attempt were made to withdraw it by tugging at the shaft. While it was no doubt perfectly possible to fasten a point of triangular shape to the shaft as firmly as a notched point, the discoveries of Mr. George H. Pepper at Tottenville, Staten Island, where twenty-three arrow points were found in and among the bones of three Indian skeletons, tend to strengthen this theory. While the majority were of bone or antler, all those made of stone were of this type, and indeed most of the bone points were also triangular in shape. However, it is well to bear in mind that arrow points of triangular type have been used for every purpose by all the early Iroquois tribes of New York.

Spear Points and Knives (Fig. 10). None of the early accounts of contemporary European writers seem to mention the use of spears (other than bone or antler-headed harpoons) by the Indians hereabouts, and it is probable that the larger arrow-point-like forms found were used as knives or cutting tools. They are usually notched or stemmed, rarely triangular, and occasionally round or oval. They vary in size, but it must be remembered that one tool may have had various uses, and that drills, knives and scrapers may often have been combined in one implement.

Scrapers (Figs. 10 and 11). Scrapers were probably used in dressing skins, and in sharpening bone implements, woodworking and for various other purposes. These are usually mere flint flakes chipped to an edge on one side. Nevertheless, notched and stemmed forms, requiring some care in their making do occur. Broken arrow points were occasionally chipped down to serve this purpose. A single serrated scraper has been found.

FIG. 10. KNIVES AND SCRAPERS

These are very rare in both the Algonkian and Iroquoian areas of New England and the Middle Atlantic States. One very large stemmed scraper, of a type more common in the far west, also comes from this locality.

Drills (Fig. 11). These are usually chipped tools presenting an elongated narrow blade and a considerably swollen or expanded base, suitable for grasping in the hand. In some cases the base was absent and those were probably hafted in wood. Specimens whose blades have a square or rectangular cross section are very rare. The finding of cores left in half-drilled objects shows the use of a hollow drill, and it has been suggested that a hard hollow reed used with sand and water on a soft stone would produce this effect. To bear out this assertion, it has been reported that a half-drilled implement has been found (outside this area on the upper Hudson) in which the remains of the reed drill were found in the cavity left by its action.

Rough Stone Articles.

Hammerstones. These vary from simple pebbles picked up and used in the rough, showing merely a battered edge or edges acquired by use, to the pitted forms. They are generally mere pebbles with a pit pecked on two opposite sides, perhaps to aid in grasping with the thumb and forefinger. Some have battered edges, but many have not, suggesting, when round and regular, a use as gaming or "Chunké" stones, or as implements used only in pounding some soft substance. Hammerstones, pitted on one side only, and others with many pits on all sides, occur. These latter may have had some special use, and are not to be confounded with the large flat, slab-like stones having pits only on one side, found in other regions, and perhaps used as receptacles for holding nuts while cracking them. While these are common in the Iroquoian area, they are unknown here.

Large stones, single or double pitted, resembling oversized hammerstones occur, and these may have been used as anvils in chipping flint or for like purposes.

Grooved clubs or mauls, also showing use as hammers are found. These are rare and are usually either rough pebbles, grooved for hafting, as in the case of the grooved axe, or grooved axes, the blades of which have become so battered, broken and rounded by wear as to preclude their further use for chopping.

Net-sinkers. On all sites near the water, either salt or fresh, net-sinkers show the prevalence of fishing. These are of two types. In one case a pebble is notched on opposite sides of either the long or broad axis; in the other a groove is pecked around the entire pebble in the same manner. The

FIG. III. DRILLS, SCRAPERS AND OTHER OBJECTS.

latter type is comparatively scarce, as the former, being more easily and quickly made, was just as useful to the savage. The modern Cree and Ojibway, residing in the forests north of the Great Lakes, still use pebbles for this purpose, but those observed by the writer were not notched or worked in any way. Occasionally, sinkers notched on both axes are found in this region.

Hoes. These are usually ovoid implements, chipped from trap rock and sometimes notched to facilitate hafting, and sometimes not. They usually show a slight polish on the blade, caused by friction with the ground. This stone type of hoe is the form mentioned by early writers; but perhaps hoes of shell, bone or tortoise shell, and wood were used also. None of these, however, are still in existence.

Hand Choppers. Pebbles chipped to an edge on one side, for use as hand choppers, occur. These are occasionally pitted on both sides.

Grooved Axes (Fig. 12). For the purposes of this paper, the writer, while aware that many grooved axes are well made and polished, has decided to include them under the head of "Rough Stone Articles," as by far the greater majority of the grooved axes and celts from this region lack the polish and finish belonging to other articles later to be described. Grooved axes are of two sorts: *a*, those made of simple pebbles, merely modified by grooving and chipping or pecking an edge; and *b*, axes which have been pecked and worked all over and sometimes polished. The latter (*b*) may be said to include:

1. Groove encircling three sides of blade, one side flat.
2. Ridged groove encircling three sides of blade, one side flat.
3. Groove encircling three sides of blade, longitudinal groove on flat side.
4. Groove encircling three sides of blade, longitudinal groove on flat side and opposite.
5. Groove encircling blade.
6. Ridged groove encircling blade.

A seventh type, having a double groove encircling the blade, may occur in this territory, but has never been reported. A specimen from the Hudson River region, just north of the area here dwelt upon, is in the Henry Booth collection in this Museum. While most worked stone axes have been pecked into shape, a few have been fashioned by chipping, but these seem to be rare.

Grooved axes were hafted in various ways. During the summer of 1908, the eastern Cree living in the vicinity of the southern end of Hudson Bay told the writer that their ancestors, who made and used such axes, hafted them by splitting a stick and setting the blade in it, then binding the handle together with deer-skin (probably rawhide) above and below the split. No specimens of the grooved axe in the original haft seem now to be extant

FIG. 12. TYPES OF STONE AXES AND CELTS.

from any locality in the East. From the battered appearance of the butts of these axes, it may have been that they were sometimes used in lieu of mauls or hammers. It is possible that they may have been used in war. It is generally supposed that in cutting down trees, making dug out canoes and other kinds of wood-working, fire was used as an adjunct to the stone axe, the former being the active agent. The process of burning and charring having gone on sufficiently, the stone axe was used to remove the burned portion. However, some stone axes seem sharp enough to cut quite well without the aid of fire.

Celts (Fig. 12). Ungrooved axes or hatchets, usually called celts, are frequent throughout this area; but are nowhere as abundant as the grooved axe, especially near the southern border of the region. The grooved axe seems to have been the typical cutting and chopping tool of the local Algonkin. The widespread idea that the celt was sometimes used unhafted as a skinning tool, has no historic proof, but may possibly have some foundation. The Cree of the southern Hudson Bay region use an edged tool of bone for this purpose, a fact which is somewhat suggestive, although the implement differs in shape from the celt. Celts with one side flat and the other beveled to an edge may have been used as adzes. From the worn and hammered appearance of the polls of some celts, it is possible that many of these implements were used as wedges in splitting wood, after constant manipulation in their chopping capacity had permanently dulled their edges.

The celts of this region are, as a general thing, poorly made, a pebble of suitable shape having an edge ground on it with little or no preliminary shaping. More rarely, however, they were carefully worked all over by pecking and polishing, as in the case of the grooved axe.

In type, aside from the general division of rough and worked celts, we may add that most celts in this region have slightly rounded polls, the bit broader than the butt, although some exceptions have been found. The forms are as follows: *a*, rough stone celts, pebbles with one end ground to an edge, but otherwise scarcely worked: and *b*, worked stone celts, which include the following:

1. Wedge-shaped, poll narrower than bit, and angles rounded; common.
2. Like number one, but with bit much broader than poll. Very rare. Cross-section oval.
3. Like number one, but one side flat, other beveled at one end to make a cutting edge.
4. Like number two, but with cutting edge flaring, broader than body. "Bell mouthed type." Very rare.

North and west of this region, we find the Iroquois territory where most

worked celts are angular, having almost invariably a rectangular cross section and squared butt. Types 1 and 3 also occur, but the celt with the rectangular cross section seems most typical of the Iroquoian region. Many small celts, made of flat fragments or chips of stone, are also found in this area, and these could scarcely have had a use as chopping tools.

In the Niagara watershed and extending eastward as far as the Genesee valley, an angular adze-like form having a trapezoidal cross section occurs. It is found principally in what was the territory of the Attiwandaronk, Kah-

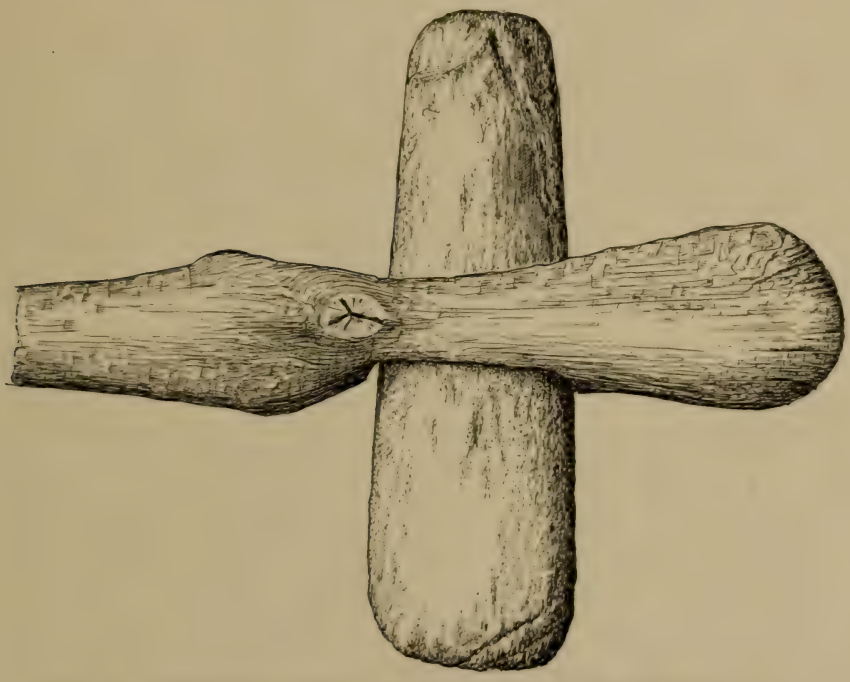


FIG. 13. A HAFTED CELT FROM A POND AT THORNDALE, DUTCHESS CO., N. Y

Length of celt 16.6 cm.

Kwah, or Neutral Nation (an Iroquoian tribe, early annihilated by the Five Nations). It also occurs, as has been stated, on the sites of villages of the Iroquois proper, but is not abundant. South of the Iroquois in central Pennsylvania, another form which does not occur in this region is the chipped celt, usually of flint or other hard stone. This form is, however, frequent in the country about the headwaters of the Delaware.

In the "American Anthropologist," Vol. 9, No. 2, p. 296 *et seq.*, Mr. C. C. Willoughby has figured and described the celts of the New England

region with remarks on the methods of hafting employed. These seem to be two in number, and consist, in the case of the larger forms, of setting the blade through a hole in the end of a club-like handle, the butt or poll projecting on one side and the blade on the other as in Fig. 13, found in the muck of a pond bottom at Thorndale, Dutchess County, New York, a region once in the Mahican territory. Smaller celts were set into a club-like handle, the butt resting in a hole or socket.

Adzes. These seem to be of two kinds, the first and most simple being celt-like, but flat on one side, the other side being beveled to an edge on one side. The second form differs in having a groove, which is not infrequently ridged. Occasionally, adzes with two parallel grooves occur. They were probably hafted by taking a stick at one end of which projected a short arm at right angles with the shaft, laying the flat side of the blade against this arm and binding it on with sinew, thongs or withes. The groove, of course, was of aid in securing the blade to the handle. Adzes of stone, hafted in this manner, have been obtained on the North Pacific coast. The celt adze seems not uncommon, but the grooved adze is rare, neither form being nearly so abundant as in the New England region.

Gouges. The stone gouge is rare, and seems always to be a plain, single-bladed affair without the transverse grooves so frequently seen in New England specimens, and hereabouts is always easily distinguished from the adze. Less than half a dozen specimens have been seen by the writer from this entire area, although probably quite as much work in wood was done by the New York coastal Algonkin as by the New England Indians.

Pestles. The long pestle occurs throughout the region of the Coastal Algonkin of New York, but is nowhere as abundant as in New England. They seem always to have been used with the wooden block mortar hereabouts, and are mentioned by the early writers as part of the household equipment of the natives. They do not seem to have been used by the Iroquois to the north and west of this area either in early or later times. The wooden pestle of dumb-bell shape seems to have been preferred by them. The latter is used by the Canadian Delaware and may have taken the place of the long stone pestle to a great extent in this region.

Mullers, Grinders, and Polishing Stones. These are frequent, and consist merely of rounded pebbles, shaped and worn by use, probably most often in crushing corn. They are mentioned by De Vries as being used by the Indians with a flat stone slab for grinding corn when traveling. Some seem to have been used for polishing stone implements, but it seems hard to draw the line, as the appearance gained from friction would be quite similar. Such mullers and their attendant slabs, used for preparing corn meal have been collected within a few years in use among the Oneida Iroquois of New York, one specimen being in the American Museum collection.

Sinew Stones. These are pebbles showing grooves along the edges, popularly supposed to have been worn there by rubbing thongs and sinews across the edges to shape them. They occur generally, but are not common.

Stone Mortars. These are common, but rather local, some sites having none at all, and others a good many. One locality on Staten Island is notable for the numbers found there, whereas they are rare elsewhere in that vicinity. They may be divided into the following types:

1. Portable mortar, hole on one side.
2. Portable mortar, hole on both sides (New Jersey type).
3. Portable slab mortar or metate, used on one or both sides.
4. Bowlder mortar, one or more holes, immovable.

The first two types are the most abundant, the third is not uncommon; but the fourth is very rare, only one or two being reported. As above stated, De Vries claims that the portable mortars were used in bread-making, while the Indians were traveling, but certainly the majority of those found are far too heavy for this purpose.

Pigments and Paint-cups. Fragments of pigments such as graphite and limonite, showing the marks of scratching with scrapers, are found, which have apparently supplied the material for painting. Worked geodes are common on many sites. These show traces of chipping in some instances and may have been paint cups. There is a tiny pestle-shaped pebble in the Museum collection from Westchester County, which is said to have been found with a geode of this type. The popular theory is that such geodes were used as "paint cups" and this seems probable.

Stone Plummets. These are very rare, in contrast to their abundance in the New England region. They consist usually of small worked egg-shaped stones, grooved at one end, probably for suspension. The writer has seen but one from this area. Their use is problematic.

Semilunar Knives. Knives of rubbed slate, similar in appearance to the "ulu" or woman's knife of the Eskimo are found, though rarely, in this region. While sometimes ascribed to Eskimo influence or contact, it is possible that this form (which occurs throughout New England), judging by its distribution, may have been native to the eastern Algonkin also. The eastern Cree still use knives of this type as scrapers. Like most other forms common in New England, it is less abundant in the southern part of this area.

Stone Beads. Various pebbles generally perforated naturally are to be found on some sites, and may or may not have been used as beads or pendants. On Staten Island, at Watchogue, Mr. Isaiah Merrill once owned a number of square beads of pinkish steatite (?), all but one of which have been lost, and which he claims were found on his farm.

Polished Stone Articles.

Gorgets. Two types of the gorget occur. These are the single-holed pendant form, which is the less abundant of the two, and the double-holed type. The latter is flat, rectangular in shape and generally well polished. It usually has two perforations a short distance from the middle. The modern Lenapé of Canada claim to have used these as hair ornaments. Probably the two-holed variety is typical of the Algonkian peoples of this region, the single-holed form being on the other hand, the most abundant on old Iroquoian sites. Specimens of the latter have been obtained in use among the Canadian Iroquois, and some of them are in the Museum collections.

Amulets. Certain problematic articles of the "bar" and even "bird amulet" type have been found, but these are probably exotic in origin and are not characteristic of the archæology of the region in question.

Banner Stones. These beautiful polished stone implements of unknown use may be divided into three great classes, with several sub-types as follows:

1. Notched banner stones.
2. Grooved banner stones.
   a. Groove on both sides.
   b. Groove on one side.
3. Perforated banner stones.
   a. Plain.
   b. Butterfly.

All three types seem equally abundant, but the notched banner stones appear to be the oldest form and occur under circumstances pointing to great relative antiquity. They are found, however, on the more recent sites as well. Both notched and grooved banner stones are usually more rough in appearance than the perforated type, and the writer has never seen a polished specimen of the first class. On the other hand, the grooved variety frequently exhibits the high degree of finish characteristic of the perforated forms. Banner stones grooved only on one side are less common than the other forms. While the latter class is generally made of slate, steatite or some similar soft and easily worked material the notched and grooved forms, especially the former, are often formed either from naturally-shaped pebbles or chipped roughly into shape. Implements, usually naturally-shaped stones with little working, without notches, grooves or perforations, but greatly resembling the notched and grooved banner stones in shape, are not infrequently found on aboriginal sites hereabouts and may have served as banner stones. There seem to be neither records nor plausible theories as to their use.

Pipes. Stone pipes, invariably made of steatite, are very rare. Four types have been noted as follows:

1. Monitor or platform pipe, platform not projecting before the bowl.
2. Monitor or platform pipe, platform projecting before bowl, with or without tiny carved stem or mouthpiece. Of the latter, one specimen is known.
3. Trumpet-shaped stone pipe.
4. Rectangular stone pipe, human face carved on front of bowl.

It may be remarked that more stone pipes have been reported from the Indian cemetery at Burial Ridge, Tottenville, Staten Island, than from all the rest of the area put together. The second and third types are represented by one specimen each from Burial Ridge and from nowhere else in this region. Four or five pipes of the first class have been found there as well. The last class is represented by a single specimen obtained by Mr. W. L. Calver at Inwood, Manhattan Island. Undoubtedly the clay pipe was the most common form used in this locality.

Steatite Vessels. These are not at all abundant, though occurring almost everywhere. They were doubtless all imported from New England, as there are no steatite quarries within the range of the New York Coastal Algonkin. The single form found is that common in the east, an oblong, fairly deep vessel with a lug, ear or handle at each end (Fig. 14j). Occasionally, such vessels are ornamented by rude incisions along the rim.

Articles of Clay.

Pottery Pipes are common everywhere. They are usually manufactured of a better quality of clay than that used for vessels, and bear fairly similar designs. They are susceptible of division into the following classes:

1. Straight pipe, bowl expanding slightly.
2. Bowl much larger than stem, leaving it at an angle of forty-five degrees. Stem round.
3. Same as number 2, but stem angular and much flattened.
4. Effigy pipes, (represented by a pottery human head apparently broken from a pipe bowl, obtained by Mr. M. R. Harrington at Port Washington, Long Island).

The straight pipe seems to have been obtained only on Staten Island on the north shore in the region occupied by the Hackensack. While nowhere as abundant as upon the Iroquoian sites of central and western New York, the clay pipe is rather common and is a prominent feature in the coast culture of New York (Fig. 15a). It is more abundant perhaps in the southern part

of the area, but this may well be due to the fact that data from this region are more easily accessible. The triangular-stemmed "trumpet" pipe so common on the Iroquoian sites is unknown in this region.

Pottery Vessels.

The pottery of this region may all be considered as being either the native Algonkian in type or showing Iroquoian influence with a third and intermediate variety. Algonkian vessels may be divided into the following groups according to shape:

1. Conical, pointed bottom, slightly swollen sides, circumference largest at the mouth, — the typical Algonkian pot of this area, Fig. 14a.

2. Like number 1, but much rounder and broader, Fig. 14b.

3. Bottom pointed, sides slightly swollen, neck slightly constricted, Fig. 14c.

4. Identical with number 2, except that just below the beginning of the neck, occur small raised lugs, ears or handles. This is rare from this area, Fig. 14d.

5. Rounded bottom, somewhat constricted neck, lip sometimes flaring, or even turning down and back, Fig. 14e.

The intermediate types are as follows:

6 Rounded bottom, constricted neck, narrow raised rim or collar, Fig. 14f.

7. Like number 6, but with sides more elongated and bottom more oval than round, heavier collar, generally notched angle, with or without a series of small humps or projections at intervals, Fig. 14g.

The Iroquoian types are as follows:

8. Mouth rounded, collar or rim heavy, with humps or peaks at intervals, angle notched, neck constricted and bottom rounded; can stand by itself, an unknown feature in local Algonkian vessels, Fig. 14h.

9. Same as number 7, but with mouth square, and humps at every angle. Much less common than the preceding, Fig. 14i.

In size, the vessels range from small toy-like pots to jars of very large capacity. In general they appear to have been made by the coil process, and are tempered with pounded stone or fine gravel, mica or burned or pounded shell. Sherds showing tempering by fibre or some other substance that disappeared in firing are rarely found. When vessels were cracked or broken, a series of holes was bored opposite each other on either side of the break and the parts laced together, rendering the vessel capable of storing dry objects, at least.

Life forms are exceedingly rare in local ceramic art. From Manhattan Island and Van Cortlandt Park, there come a number of specimens showing incised human (?) faces. This is not an uncommon form on Iroquoian sites in central and western New York. On the Bowman's Brook site at Mariner's Harbor, Staten Island fragments of a typically Algonkian pot were obtained which bore at intervals, rude raised faces. With the sole exception of a rather well-modeled clay face, apparently broken from the

FIG. 14. POTTERY FORMS OF THE COASTAL ALGONKIN.

bowl of a pipe (Fig. 15b) found at Port Washington,[5] Long Island, by Mr. M. R. Harrington, this brief statement concludes the list of pottery life forms reported from this area, although others may yet be found here, since some interesting objects have been collected in immediately adjacent territory.

The forms of decoration consist of stamping with a stamp, roulette or paddle, and incision (Figs. 16 and 17.) Occasionally, but very rarely,

stucco work occurs. Under stamping we can enumerate the following processes:

1. Impression with the rounded end of a stick (rare).
2. Impression with the end of a quill, or hollow reed, leaving a circular depression with a tiny lump or nipple (rare) in the center.
3. Impression with a section of a hollow reed, making a stamped circle (rare).
4. Impression with finger nail (doubtful, but perhaps used on some sherds from Manhattan Island).
5. Impression of the edge of a scallop shell.
6. Impression with a carved bone, antler or wooden stamp.
7. Impression of a cord-wrapped stick.
8. Impression with roulette.

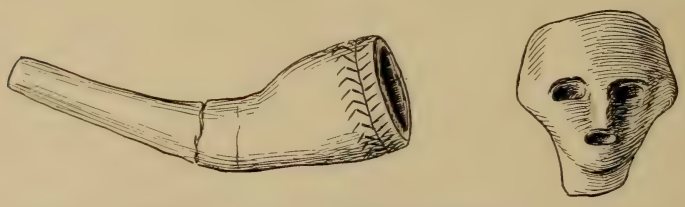


FIG. 15. TYPICAL ALGONKIAN POTTERY PIPE AND FRAGMENT OF AN EFFIGY PIPE FROM PORT WASHINGTON, L. I

Under the head of decoration by incision we can enumerate the following:

9. Incised decoration, probably made with a stick.
10. Incised decoration, possibly made with a flint object (only one specimen at hand).

The paddle was frequently used to finish the sides and bottom of the pot by imparting an appearance of pressure with fabric when the clay was wet.

11. Stucco. Occasionally, ridges of clay placed on the rim for ornament appear to have been added after the shaping of the vessel.

Ornamentation is usually external, and vessels, either Algonkian or Iroquoian, are rarely ornamented below the rim, although occasionally the designs run part way down the side in the case of the Algonkian forms. Where decoration has been applied by one of the stamping processes, and more rarely by incision, it is sometimes continued over the lip or rim for an inch or less on the inside. This only occurs in the typical Algonkian forms, and is never seen when incised ornamentation is used. The rims of Iroquoian vessels are never ornamented on the interior, nor is stamping so frequently practised on vessels of this class. The intermediate forms, at least the first of the two mentioned, are frequently ornamented on the interior

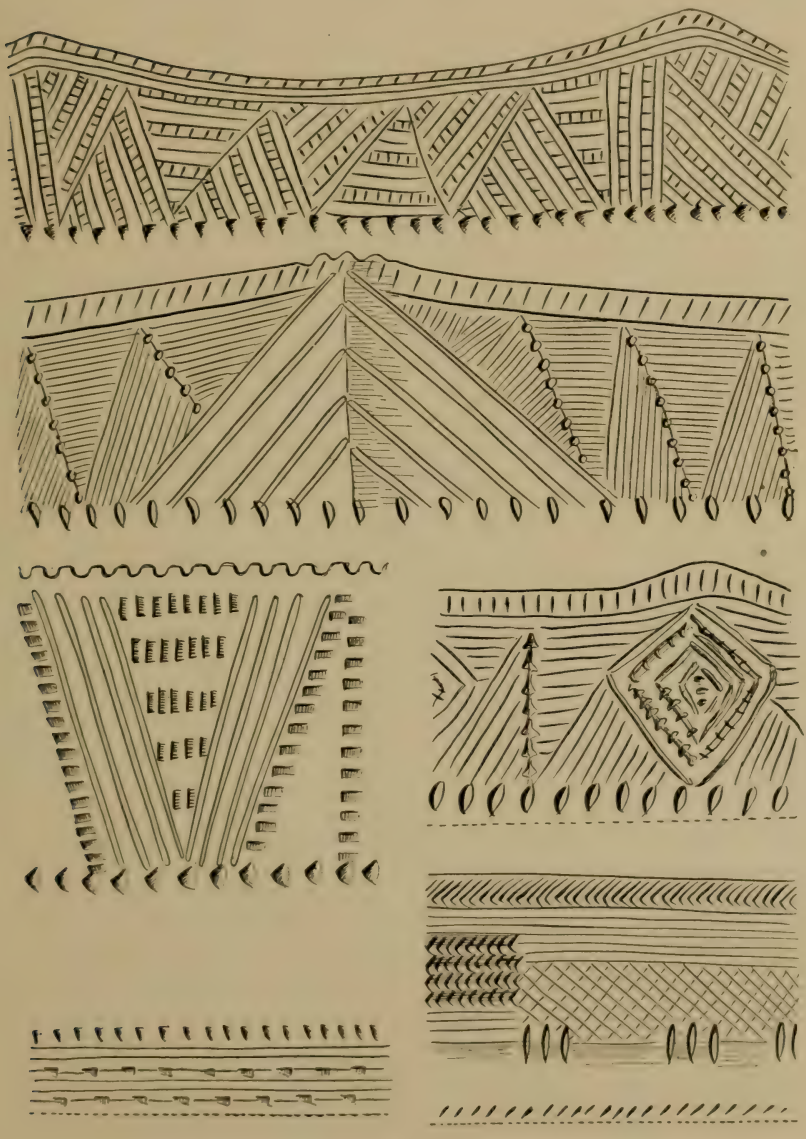


FIG. 16. INCISED DESIGNS FROM POTTERY VESSELS.

a, *b*, and *d*, designs from Iroquoian vessels; *c*, design from an Algonkian vessel; *e*, design from a vessel of the Iroquoian type from a Connecticut rock-shelter, introduced here for comparison.

of the lip. This internal decoration is much more common in the southern portion of this area than elsewhere in the vicinity.

In design, we must of course, give up all thought of trying to obtain symbolism, if such there were, for there are no sources now left upon which to base our assumptions. Certain conventional types of decoration seem to have been in vogue, usually consisting in rows of stamped or incised parallel lines and much more rarely of dots regularly arranged in the same manner. Zigzag, chevron and "herring bone" patterns are the most common, but other angular forms occur, and rows of parallel lines encircling the vessel are sometimes to be found. Stamping and incision as decorative processes never seem to occur on the same vessel. Curvilinear decoration is exceedingly rare, and not enough material is at hand to show that patterns were used, possibly these were scrolls of some form. On account of the lack of material, it cannot be determined whether the designs on the Algonkian

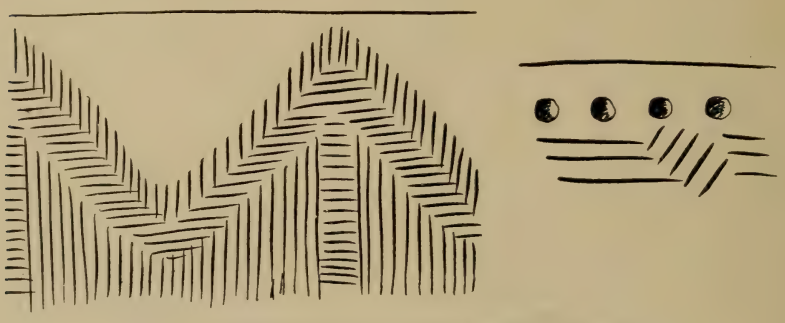


FIG. 17. INCISED DESIGNS FROM ALGONKIAN VESSELS.

vessels differ from those on the Iroquoian, except in a very general and unsatisfactory way.

The angle formed where the heavy rim or collar leaves the constricted neck of the Iroquoian vessel is almost invariably notched, and as such collars and angles do not occur on vessels of the true Algonkian type, this feature is necessarily absent from them. It is noticeable that Iroquoian vessels are usually decorated with incised designs, rather than stamped patterns.

Pottery is found abundantly on the majority of the sites in this district; but, while very much more common than in the New England area, it does not equal in abundance that from the Iroquois country. It is rarely found buried in graves with skeletons as in the Iroquoian area; when sometimes found in graves, however, it is usually at some distance from the human remains and apparently not connected with them. Whole or nearly whole vessels are exceedingly rare and the number of those found up to date may

easily be counted upon the fingers. Potsherds taken from pits or shell heaps, where they have not been exposed to the action of the weather, are often as thickly covered with grease as when they were broken and cast aside.

Articles of Metal.

Beads. Beads of native metal, consisting simply of pieces of hammered sheet copper rolled into small tubes, have been found, but they are very rare. Copper salts, but no objects, were found upon the bones, especially on those of the head and neck, of a child's skeleton at Burial Ridge, Tottenville, Staten Island, which seemed to predicate the use of copper beads. A great many beads of *olivella* shell, some of them discolored by copper salts, were found about the neck of the skeleton. A single celt of copper is said to have been found in Westchester County, probably on Croton Neck, slightly above the limit of the territory treated in this paper.[1]

Articles of Shell.

Wampum. Objects of shell are not at all common, and notwithstanding the coast region of New York was one of the best known localities for wampum manufacture on the continent, wampum beads are almost unknown from local sites. With the exception of completed beads, most of which may have been shipped into the interior, wampum may be found in all stages of manufacture. We refer to the white wampum, for traces of the "black" (blue) wampum made from the hard clam or quahog are so far not reported. The process of manufacture may be shown by shells with the outer whorls broken away in steps until the innermost solid column is reached, ground and polished at the end, and needing only cutting off into sections and perforations to make the finished white wampum bead. These do not occur on all sites, though they have been found here and there throughout the region. Ninety-six conch shells with the outer whorls broken entirely away were found in a grave at Burial Ridge, Tottenville, Staten Island, about the head and neck of a skeleton.

Pendants. Occasionally oyster and clam shells, found unworked save for perforations in them, may have been pendants or ornaments, but certainly have little æsthetic value.

Scrapers. Clam shells seem to have been used as scrapers and some are

[1] Native copper occurs in the New Jersey trap ridges, within a few miles of New York City, an important source in Colonial times being near Boundbrook 30 miles from the lower end of Manhattan Island. Bowlders of native copper occur in the glacial drift. Editor.

occasionally found with one edge showing the effect of rubbing and wearing. These are rare, however. Some may have been pottery smoothers. Clam shells have been reported which contained central perforations and were identical in appearance with some shell pottery scrapers and smoothers collected by Mr. M. R. Harrington among the Catawba. Contemporary writers mention the use of knives made of shell.

Pottery Tempering. This was sometimes done with calcined and pounded shells, but was uncommon, considering the abundance of the material at hand. Pounded stone or gravel seems to have been more favored.

Pottery Stamps. The corrugated edge of a scallop shell was frequently used as a stamp for pottery, as may be seen by examining the potsherds from this region.

Articles of Bone and Antler.

Objects of bone and antler, while perhaps more abundant here than in New England, are far less plentiful in form and number than in the Iroquoian area. Cut bones are frequent in most shell pits and heaps. They were cut by grooving the bone partly through on all sides, probably with a flint knife, and breaking.

Bone Awls. These utensils are the most common of all bone articles in this region and are found in almost every part of the area. Some are merely sharpened slivers, but others show a considerable degree of work, and are well finished and polished. They are usually made of deer or other mammal bone, but sometimes from the leg bones of birds.

In some instances, the joint of the bone is left for a handle, but this is often cut off. Grooved, perforated or decorated bone awls are extremely rare in this region. While it is generally considered that these bone tools were used as awls in sewing leather, as by modern shoemakers, nevertheless, they may have served as forks in removing hot morsels from the pot or for a number of other purposes. The latter supposition is supported by the abundance of bone awls found in some shell pits. The northern Cree of the Hudson Bay region use a similar bone implement as the catching or striking pin in the "cup and ball" game.

Bone Needles. These are rare, but found in most localities. They are generally made of the curved ribs of mammals and are six or eight inches long, or even longer. They are generally broken across the eye, which is usually midway between the ends. A few with the perforation at one end have been reported.

Bone Arrow Points, usually hollow and conical in shape, have been found,

especially at Tottenville, Staten Island, in the Burial Ridge. They are rather rare, but this may be due to the fact that conditions are not suitable for their preservation in most localities. Others are flat and triangular in shape.

Harpoons. No actual barbed bone harpoons, such as occur in the Iroquois country have been reported from this region; although the writer has seen what appeared to be part of one from Shinnecock Hills, Long Island, whence comes a harpoon barb of bone, found by the writer, now in the Museum collection, which was apparently made to tie to a wooden shaft. While neither of these forms seems to occur within this region, several naturally barbed spines from the tail of the sting-ray, found on the Bowman's Brook site, at Mariner's Harbor, Staten Island, may have been used as harpoons or fish spears, for which purpose they were admirably suited by nature. Long, narrow, chipped stone arrow-heads are generally called "fish points", but they do not seem peculiarly adapted for this purpose and the name is probably a misnomer. No bone fish hooks are reported from hereabouts, though suggested by early writers.

Bone Beads and Tubes. While so abundant on Iroquoian sites, tubes and beads made of hollow bird or other animal bones, polished and cut in sections, are very rare here.

Draw Shaves, or Beaming Tools, made of bone, and probably used for removing the hair from skins, were made by splitting the bone of a deer's leg, leaving a sharp blade in the middle with the joints on either end as handles. The writer has seen none from this immediate region, but they are reported by Mr. M. R. Harrington. A number were obtained for the Museum by Mr. Ernst Volk in the Lenapé sites near Trenton, New Jersey. An implement, evidently made of the scapula of a deer, and perhaps used as a scraper, was found in a grave at Burial Ridge, Tottenville, Staten Island, by Mr. George H. Pepper.

Worked Teeth. Perforated teeth of the bear, wolf and other animals, so abundant on Iroquoian sites never seem to be found here. Beavers' teeth, cut and ground to an edge, occur, and may have been used as chisels, or primitive crooked knives, or both, as they were till recently by some of the eastern Canadian Algonkin. Other cut beaver teeth may have served as dice or counters in gaming.

Turtle Shell Cups. These are common, and consist merely of the bony carapace of the box turtle (*Tranene caroline*), scraped and cleaned inside, the ribs being cut away from the covering to finish the utensil for use.

Antler Implements. Deer antlers and fragments of antler, worked and unworked, occur in all shell heaps and pits. When whole antlers are found, they usually show at the base the marks of the axe or other implement used

Siwanoy.
Weckquaskeck.
Wappinger.

C. Montauk or Matouwack Confederacy.
Canarsie.

These tribes were surrounded on all sides by neighbors of the same stock, who differed somewhat in their language and culture. On the south and west, lay the Lenni Lenapé, or Delaware proper; on the north, the Manhattan, and on the east the New England tribes. Almost without exception, these natives were displaced early in the history of this country, and have been long since expatriated or exterminated. A very few mixed bloods may yet be found on Staten Island, Long Island and in Westchester County, but their percentage of Indian blood is extremely low.

The remains of aboriginal life now to be found, consist of shell heaps, occurring at every convenient point along the coast, on the rivers, and, more rarely, inland; shell, refuse, and fire pits; camp, village and burial sites; and rock and cave shelters. With one prominent exception,[1] few or no relics have been found in graves. The typical interment was of the flexed variety, but bone burials are not infrequent.

Dog skeletons complete and intact, bearing the appearance of having been laid out, are sometimes found buried in separate graves. Some writers have supposed that these individual dog burials are the remains of "white dog feasts" or kindred practices, because the Iroquois even up to the present day hold such ceremonies. The white dog is entirely cremated by the Iroquois, and so far as we have been able to find out, there is no record of such occurrences among the coastal Algonkin; hence, there seems no reason to attribute this custom to them since other Iroquois traits were so infrequent. It seems more probable that such burials are simply those of pet animals, interred as we to-day honor a faithful dog.

Occasionally, the skeletons of dogs and rarely of other animals have been found in graves associated with human bones. The finding of arrow-heads among the ribs of some of these, and other circumstances, seem to point to a practice of killing a favorite animal on the death of its owner to accompany or protect the spirit of its master on the journey to the hereafter.

From their appearance and position, many graves seem to indicate that the dead may sometimes have been buried under the lodge, especially in time of winter, when the ground outside was frozen too hard to permit grave digging. Others under the same circumstances seem to have been buried in refuse pits. The remains further indicate that "feasts of the dead," were

[1] Burial Ridge, Tottenville, Staten Island.

also held at the time of the interment, judging by the quantity of oyster shells and animal bones in and near the graves. Some graves have rows or layers of oyster shells, with the sharp cutting edge upward, placed above the bodies as if to prevent wild animals from disinterring and devouring the dead.

An interesting fact, brought to light by the rock-shelter work of Messrs. Schrabisch and Harrington in their explorations in New Jersey and Westchester County, New York, is that in the lowest and oldest refuse layers of these shelters pottery does not occur. It would be ill advised to infer from this that the earliest occupants were peoples of another culture from the surrounding village dwellers, as the other artifacts found are quite similar to the implements of the latter. Many reasons for this lack of pottery, such as the more easy transportation of vessels of bark or wood through the mountains and hills, suggest themselves, though they are more or less nullified by the presence of pottery in the upper layers. The upper layer, however, may have been made during the period when the natives were being displaced by Europeans and at the same time subjected to Iroquoian raids, when the villages would naturally be abandoned from time to time, for refuge among the cliffs and caves of the mountain fastnesses.

It has been suggested that the rock and cave shelters are remains of an older occupation by people with or without the same culture as the later known savages. The nature of the finds does not support this view, for the specimens obtained are often of as good workmanship as the best to be found in the villages and cemeteries of the latter, while pottery, on the other hand, occurs on the oldest known Algonkian sites. It seems most probable to the writer that, like the shell heaps, the rock and cave shelters form but a component part, or phase, of the local culture, perhaps a little specialized from usage and environment, but contemporary with the villages, shell heaps and cemeteries of the lowlands.

Mounds and earthworks do not occur in the region under consideration, nor does it appear that most of the Indian villages here were fortified, unless they were slightly stockaded. A number of instances of this are known historically, however, and a few earthworks occur just beyond this area.[1]

The remains found do not bear any appearance of very great geological antiquity. In a few instances, rock-shelters, shell heaps and village sites seem to possess a relative antiquity; but the oldest known remains, in every case, may be placed as Algonkian with considerable certainty. No paleoliths have been reported, and it would seem from the comparative lack of antiquity of the remains that the natives could not have lived in this region for many centuries before the advent of the whites. The accounts of con-

[1] An earthwork at Croton Point on the Hudson has been excavated by Mr. M. R. Harrington for the American Museum.

temporary writers prove conclusively that these archæological remains, if not those left by Indians found here by the early Dutch and English settlers, must have been from people of very similar culture. In culture, the local Indians were not as high as the Iroquois, nor perhaps as the Lenapé or Delaware proper from whom they sprang; but they compare very favorably with the New England tribes. Absence and scarcity of certain artifacts such as steatite vessels, the long stone pestle, the gouge, adze and plummet, and the abundance and character of bone and pottery articles show them to have been intermediate in character between the Lenapé on the south and west, and the New England tribes on the east and north; and consultations of the old European contemporaries show that this was the case linguistically as well as culturally. Examination of the remains also shows that the influence of the Lenapé on the west, and of the New England peoples on the east, was most strongly felt near their respective borders. Iroquoian influence was strong, as evinced by the pottery, and there is also documentary evidence to this effect. Finally, as is frequent throughout most of eastern North America, the archæological remains may be definitely placed as belonging to the native Indian tribes who held the country at the time of its discovery or to their immediate ancestors.

Historical Notes on the Indians of Manhattan.[1]

Historical references to the Indians who occupied this territory in the early days are very confusing and contradictory. There seems to be a great deal of trouble in the use of the word Manhattan. Van der Donck in 1633 classified the Indians of this section by language, and said, "Four distinct languages — namely Manhattan, Minqua, Savanos and Wappanoos" — are spoken by Indians. "With the Manhattans we include those who live in the neighboring places along the North River, on Long Island, and at the Neversinks."[2] It is probable that "it was. . . . this classification by dialect that led the Dutch to the adoption of the generic title of Manhattans as the name of the people among whom they made settlements."[3] De Laet wrote that "on the east side, on the mainland, dwell the Manhattans," and in 1632 Wassenaer adds that they are "a bad race of savages, who have always been unfriendly to our people" and that "on the west side are the Sanhikans, who are the deadly enemies of the Manhattans."[4] "When Hudson returned from his trip up the River which now

[1] First paragraph by James K. Finch.
[2] Wilson, Memorial History of N. Y., Vol. I, p. 34.
[3] Ibid., p. 49.
[4] Ibid., p. 34.

bears his name, he was attacked by Indians in birch or dug-out (?) canoes at the mouth of Spuyten Duyvil Creek. These Indians were a sub-tribe of the Wappingers or Wapanachki called the Reckgawawanes." [1] This name seems to have been given to the Indians who inhabited Manhattan Island, while the term Manhattans as already stated was a classification of dialect only. Ruttenber says that the Reckgawawanes were named after their chief Rechgawac; [2] and the name also seems to have been applied to part of the island for Riker says that,— "The Indians still [in 1669] laid claim to portions of the Harlem lands, ...one of the tracts being their old and favorite haunt Rechewanis, or Montagne's Point. The chief claimant was Rechewack, the old Sachem and proprietor of Wickquaskeek, who, as far back as 1639, had been a party to the sale of Ranachqua and Kaxkeek." [3]

Not much is known of their habits and customs beyond what has been inferred from the relics to be seen in this exhibit, but Mr. Bolton writes:

"We are not without detailed description of our primeval predecessors upon the island of Manhattan, for the Hollanders recorded many of their impressions of aboriginal peculiarities. We may assume that they possessed the usual characteristics, the stolid demeanor, the crafty methods, and revengeful nature of the Indian, all of which were exhibited in their dealings with the White intruders. These local bands appear to have had, in addition, some particular local habits. They painted their faces with red, blue, and yellow pigments, to such a distortion of their features, that, as one sententious Dominie expressed it, 'They look like the devil himself.' Their dependence on supplies of game and fish caused their removal from one place to another, semi-annually, and we read of their removal to a summer 'hunting-ground' in Westchester, whence the band returned to 'Wickers Creek,' for the winter shelter, and to resume their occupation of oystering and fishing in the Harlem and Spuyten Duyvil Creek.

"As for dress, 'They go,' said Juet, 'in deerskins, loose well-dressed, some in mantles of feathers, and some in skins of divers sorts of good furres. They had red copper tobacco pipes, and other things of copper they doe weare about their neckes.'

"No copper objects have been found in upper Manhattan, probably their metallic stock was bartered away with the early colonists, for in 1625, De Laet described their use of 'Stone pipes for smoking tobacco.'

"As regards their food, the evident abundance and size of the local oyster shells shows that they possessed in them a ready source of subsistence. As soon as Hudson's ship reached the neighborhood of Greenwich, where the

[1] Ibid., p. 46.
[2] Ruttenber, op. cit., p. 78.
[3] History of Harlem, p. 287.

Indian Village Sappokanikan was located, the natives 'brought great store of very good oysters aboard, which we bought for trifles.' De Laet (1625) says, 'their food is maize, crushed fine and baked in cakes, with fish, birds and wild game.' Van der Donck and others wrote in 1649:

> Their fare, or food, is poor and gross, for they drink water, having no other beverage; they eat the flesh of all sorts of game that the country supplies, even badgers, dogs, eagles and similar trash, which Christians in no way regard; these they cook and use uncleansed and undressed.
>
> Moreover, all sorts of fish; likewise, snakes, frogs and such like, which they usually cook with the offals and entrails.
>
> They know also, how to preserve fish and meete for the winter, in order then to cook them with Indian meal.
>
> They make their bread, but of very indifferent quality, of maize, which they also cook whole, or broken in wooden mortars.
>
> The women likewise perform this labor, and make a apa or porridge called by some, Sapsis, by other, Duundare, which is their daily food, they mix this also thoroughly with little beans, of different colors, raised by themselves; this is esteemed by them rather as a dainty than as a daily dish.

"Their weapons were, of course, the usual aboriginal bow, arrow, spear, club and tomahawk, though but a few years later, they had acquired from the settlers enough fire-arms to become exceedingly expert in their use. 'Now, those residing near, or trading considerably with the Christians, make use of fire-locks and hatchets, which they obtain in barter. They are excessively fond of guns; spare no expense on them, and are so expert with them, that in this respect they excell many Christians.' Many of their discarded neolithic weapons have been found, and these exhibit a wide variety of material and workmanship, indicating considerable acquisitions from other tribes and localities. Their household utensils included 'mats and wooden dishes,' and Juet refers to their 'pots of earth to dresse their meats in,' and speaks also of the women bringing 'hempe.' The character of the grass mats which the women wove is to be seen in the imprints made with such material upon the outer surface of some of the local pottery. They also made the grass baskets, often referred to in early records, as 'napsas.' The pots of earth were the large earthenware vessels made by the Indian women, on the decorations of the rims and upper portions of which these poor creatures expended all their ingenuity and sense of art.

"Of these objects, there remain a number of interesting examples discovered in upper Manhattan, the most complete, and at the same time, most artistic, being the fine Iroquoian vessel discovered by Mr. W. L. Calver, on the south side of 214th Street, about 100 feet east of 10th Avenue, in the fall of 1906. The large vases found in broken condition in the cave at Cold Spring, are of the cruder and therefore, earlier design of the original

Algonkian inhabitants, who at a later period, probably by barter, and perhaps by inter-marriage, acquired or learned the art of Iroquoian design and decoration.

"Of the period during which the race occupied this locality, we can only make conjectures. The extent and character of the shell heaps at Cold Spring and the pits and burials at Seaman Avenue, certainly indicate a settlement of large numbers or of considerable age. The ceremonial pits at 212th Street and certain remains of aboriginal feasting, such as fish bones and oyster shells, appeared to exist at a level below the graves of the slaves of the settlers, buried at that place.

"While these conjectures may carry back the period of occupancy to antiquity, the tools and weapons are all of the modern order, and no objects of true paleolithic character have been discovered, so that we have as yet nothing definitely reaching back into the remote ages of the most primitive mankind, although on Hunt's Point in the Bronx, at no great distance away from our island, a very interesting rude ax and a hammer were discovered by Mr. Calver in a gravel-pit, near the old Hunt burying-ground."

Location of Archæological Remains on Manhattan Island.[1]

The first field work done on Manhattan Island is of very recent date. Doubtless many articles of Indian manufacture and evidences of Indian occupation were found as the city grew up from its first settlement at Fort Amsterdam, but of these specimens we have very few records. The first specimens found which have been preserved, to the knowledge of those now interested in the subject, were found in 1855, and consisted of a deposit of Indian arrow-points found in Harlem during excavation for a cellar on Avenue A, between 120th and 121st Streets. Some of these are spoken of by James Riker [2] as being in the author's cabinet. Riker also speaks of shell heaps near here.[3] The next specimens preserved were found at Kingsbridge Road (now Broadway) and 220th Street in 1886, and are in the John Neafie collection at the Museum. These consist of an arrow point and a few bits of pottery. The next work was begun in 1889 by Mr. W. L. Calver of this city, and has led to the discovery of much valuable material which has been preserved.[4]

[1] By James K. Finch.

[2] History of Harlem (1881), footnote, p. 137.

[3] Ibid., p. 366.

[4] In the Spring of 1890 Mr. Edward Hagaman Hall began his investigations and at about the same time Mr. Reginald P. Bolton entered the field of local research. In many instances these gentlemen and Mr. Calver collaborated with valuable results. In the preservation of the traces of Indian occupation of Manhattan Island the American Scenic and Historic Preservation Society (formed in 1895 under the presidency of the late Hon. Andrew H. Green, but now under that of Dr. George Frederick Kunz) has done much pioneer work. Editor.

The following account of the work is taken mainly from Mr. Calver's note-book:

In the autumn of the year 1889, while exploring the heights of Bloomingdale (now called Cathedral Heights) for any relics that might have remained from the Battle of Harlem, Mr. Calver discovered one arrow point at 118th Street, east of Ninth Avenue, and immediately afterwards a circular hammerstone. On a later trip to the same locality, he found a small grooved axe or tomahawk.[1] In February, 1890, while hunting for Revolutionary relics in the vicinity of Fort Washington, he made a trip to the northern part of the Island in search of British regimental buttons, many of which were said to have been found in that vicinity. There he met an old acquaintance, Mr. John Pearce, a policeman then on duty there, by whom he was introduced to Mr. James McGuey, a youth residing in the vicinity of 198th Street and Kingsbridge Road. To Mr. Calver, Mr. McGuey presented several relics found by himself on camp sites and made an appointment to meet him early in March to explore for Indian remains. The same day, Mr. Pearce took Mr. Calver to be introduced to Mr. Thomas Reefe who resided near Kingsbridge Road and Isham Avenue, and, while crossing the orchard at Academy Street and Seaman Avenue, Mr. Calver saw that the ground was thickly strewn with shells which afterwards proved to be of Indian origin.

The first Sunday in March, Messrs. Calver and McGuey explored this part of the Island for Indian remains. At the junction of Academy Street and Prescott Avenue, they found an Indian potsherd whose importance Mr. McGuey seemed to realize, for, a week later, Mr. Calver met him again and was presented by him with a number of fragments of Indian ware. He assured Mr. Calver that he had found it by digging in an Indian graveyard. The two men dug again at this place, now known as "the Knoll," and found more pottery. They then went to Cold Spring, a point on the extreme northern end of the Island, and in a shell heap there they found more Indian work. Mr. Alexander C. Chenoweth, an engineer, then on the Croton Aqueduct, hearing of these discoveries, obtained a permit from the property owners and began to explore "the Knoll" for Indian remains. Having finished here, he went to Cold Spring and made some further discoveries. All his specimens were purchased in 1894 by the Museum, and some of them are now on exhibition.

Since this time, several interesting relics have been found and, as the work of grading streets and other excavation at this part of the Island are carried on, more relics will probably come to light. An account of the recent finds will be found in another part of this Guide, the time of this writing having been 1904.

[1] The writer found an arrowhead on South Field, in front of Columbia University Library, on September 30, 1904.

The only Indian remains left on the Island, so far as known to the writer, are situated at the extreme northern end at Inwood and Cold Spring. They consist of the co-called shell heaps or refuse piles from Indian camps, and three rock-shelters at Cold Spring. But we have evidence to show that this was not the only part of the Island occupied by the Indians. Mrs. Lamb [1] says that the Dutch found a large shell heap on the west shore of Fresh Water pond, a small pond, mostly swamp, which was bounded by the present Bowery, Elm, Canal and Pearl Streets, and which they named Kalch-Hook or shell-point. In course of time, this was abbreviated to Kalch or Collect and was applied to the pond itself.[2] This shell heap must have been the accumulation of quite a village, for Mrs. Jno. K. Van Rensellaer [3] speaks of a castle called Catiemuts overlooking a small pond near Canal Street, and says that the neighborhood was called Shell Point. Hemstreet refers to the same castle as being on a hill "close by the present Chatham Square," and says that it had once been an "Indian lookout." [4] Excavations at Pearl Street are said to have reached old shell banks. "The Memorial History of New York" [5] says that a hill near Chatham Square was called Warpoes, which meant literally a "small hill." [6] According to the same authority, "Corlear's Hoeck was called Naig-ia-nac, literally 'sand-lands.' It may, however, have been the name of the Indian village which stood there, and was in temporary occupation." This is the only reference we have to this village, but there are references to another on the lower end of the Island. Janvier [7] says that there was an Indian settlement as late as 1661 at Sappokanican near the present Gansevoort Market. According to Judge Benson,[8] Sapokanican was the Indian name for the point afterwards known as Greenwich. "In the Dutch records references are made to the Indian village of Sappokanican; and this name....was applied for more than a century to the region which came to be known as Greenwich in the later, English, times. The Indian village probably was near the site of the present Gansevoort Market; but the name seems to have been applied to the whole region lying between the North River and the stream called the Manetta Water or Bestavaar's Kill." [9] Benton says that the name of the

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[1] History of New York City, p. 36.

[2] Mr. Edward Hagaman Hall, however, derives the name from "Kolk" or "Kolch" a word still in use in Holland and applied to portions of a canal or inclosure of water. The word also means "pit hole", which aptly describes the Collect Pond.

EDITOR.

[3] Goede-Vrouw of Manahata, p. 39.

[4] Hemstreet, Nooks and Corners of Old New York, p. 46.

[5] Bulletin, N. Y. State Museum, Vol. 7, No. 32, p. 107, Feb., 1900.

[6] James G. Wilson, op. cit., p. 52.

[7] Evolution of New York.

[8] N. Y. Historical Society Collection, S. II, Vol. II, Pt. I, p. 84, 1848.

[9] Thos. A. Janvier, In Old New York, pp. 85–86.

village was Lapinican.[1] Going back to the old Dutch records might lead to finding the actual names and other data regarding these places.

Most of the specimens found on Manhattan Island, as already stated, come from the northern part. We have a few from the central portion, however. There are the arrow-heads spoken of by Riker, and in Webster Free Library there is a fine specimen of a grooved stone axe found at 77th Street and Avenue B. Mr. Calver has found an arrow-head at 81st Street and Hudson River and specimens from the site of Columbia College have been recorded.

Doubtless the northern part of the Island was inhabited for the longer period; but it is probable that all along the shore, wherever one of the many springs or small brooks, shown on old maps, emptied into the Hudson or East River, there were small, temporary Indian camps. It is likely that these camps were used only in summer, while the primitive occupant of Manhattan retreated to the more protected part of the Island, as at Inwood and Cold Spring, during the winter. Or it may be possible that, as Ruttenber [2] states, the villages on Manhattan Island were only occupied when the Indians were on hunting and fishing excursions, while their permanent villages were on the mainland. Bolton,[3] however, says their principal settlement was on Manhattan Island.

Fort Washington Point. There is a small deposit of shells, on the southern edge of the point, in which the writer found some small pieces of pottery and a few flint chips, thus proving its Indian origin. This was probably a summer camp, as it was too exposed for winter use.

The Knoll. "The Knoll" was the name applied to a small rise of land, at the southwest corner of Dyckman Street and Sherman Avenue, which ran out into Sherman Creek from the eastern edge of the hill at that place. As already stated, Messrs. Calver and McGuey found potsherds here; then Mr. Chenoweth obtained permission of the property owners to make excavations. He found numerous fragments of arrow points and pottery in some refuse deposits from an Indian camp and also uncovered what were thought to have been "paved fireplaces." The newspapers of the time had accounts of the finds, with pictures of the pottery and other objects found.[4] Mr. Chenoweth also uncovered a number of skeletons. It is stated that these graves were marked with rough headstones, and there are pieces of a coffin from here in the Terry collection in the American Museum, as are also a number of lead buttons found with one interment. Everything seems

[1] New York, p. 26.
[2] Indian Tribes of Hudson's River, p. 78.
[3] History of Westchester County, p. 25.
[4] New York Herald, January 14, 1894; also Illustrated American, September 19, 1901.

to point to these as being burials of early settlers, but Mr. Chenoweth holds that they are Indian. Several of the skeletons have been preserved in the Museum. A parallel condition to this at the Knoll was found at 211th Street and will be spoken of later. The Knoll site had undoubtedly been an ancient Indian camp. Probably Sherman Creek was open up to this point to Indian canoes.

Cold Spring. Cold Spring is situated at the extreme northern end of Manhattan Island on the southern shore of Spuyten Duyvil Creek. The Indian remains consist of three rock-shelters and three refuse heaps. The rock-shelter is a formation where the overhanging rocks form a small cave or shelter which the Indians used as a dwelling place. All their rubbish, such as oyster shells, broken pottery and broken arrow heads, were dumped near by, forming the so-called shell heaps. Messrs. Calver and McGuey explored the shell heaps; but Mr. Chenoweth was the first to suspect the existence of the shelters. There is only one which is likely to have been used as a dwelling place, the others being places where food was stored or shelters for fires used in cooking. These shelters face east, and are at the foot of the hill (formerly called Cock Hill) which forms the most northern part of Manhattan Island. The largest one was formed by several of the rocks breaking off the cliffs above and falling in such a manner that, by digging out some of the earth from beneath them, the Indians could make a small shelter. Probably it was occupied by one family, while the others lived in bark wigwams near by.[1] Another of the shelters is simply an excavation under the end of a huge fragment which also dropped from the cliffs above, and the third is a large crevice in the foot of these cliffs. When Mr. Chenoweth first explored them, all these shelters were completely filled with earth which had gradually worked its way in since their occupation, and much credit is due him for suspecting their presence. In them he found fragments of pottery and stone implements, together with the bones of turkey and deer. The largest of the refuse heaps is situated on a rise directly in front of these shelters. It consists of a layer of shells, in places several inches thick, found under a layer of fine loam, a black earth which has been deposited since the shells were scattered over the original sandy yellow soil. The sheltered position of this place made it an especially desirable camp site. The hills to the south and west formed a protection to the camp from winds, and by Spuyten Duyvil Creek access could be had to either Hudson or East River; while the Cold Spring, from which the place takes its name, furnished an abundant supply of fresh water.

[1] Memorial History of New York, Vol. I, p. 33, for picture of houses, and p. 39 for description.

Inwood Station Site. At the foot of Dyckman Street and Hudson River, there existed a large deposit of shells, most of which were removed when the rocks on which they lay were blasted away for grading the street. A few arrow points and bits of pottery, as well as several Revolutionary objects, were found here. Part of the deposit is still left on the northern shore of the small bay just below Inwood station. There are photographs of this deposit in the Museum.

Harlem Ship Canal. Formerly at 220th Street and Kingsbridge Road was a large deposit of shells on the westerly side of the road. This was destroyed when the ship canal was put through. As with the Inwood Station site, no systematic examination of this place was ever made. Mr. John Neafie found some potsherds here in 1886, and Mr. Chenoweth also has some potsherds from here.[1] Mr. Calver says that this was a large deposit, and that the peculiar thing about it was that the shells were so wedged and packed together that a pick would hardly penetrate them. They lay on the bare rock surface in cracks in the rock.

Harlem River Deposit. Mr. Calver says, "Extending from 209th Street to 211th Street on the west bank of the Harlem River and almost on a line with Ninth Avenue was another large deposit of oyster shells lying just beneath the top soil of the field. These shells had nearly all been disturbed by the plow and are interesting only for their color, which was red. Pieces of horn of deer and split bones of the same animal were common among the shells; but, in spite of the apparent antiquity of the deposit, there were, even in the lowest strata of it, some small fragments of glass which proved that either the whole mass had been disturbed or else the shells had been left during the historic period. There are several stone sinkers and hammerstones from this spot in Mr. Calver's collection and at the Museum.

Isham's Garden. This is a large garden about on the line of Isham Street and Seaman Avenue. The soil is white with small fragments of shells. A number of arrow points, flint chips, hammerstones, sinkers and a few bits of pottery have been found here. Mr. Calver has found several shell pockets with small deposits of pottery, etc., on the hill to the south of this garden.

Academy Street Garden. This is a small garden between Academy and Hawthorne Streets, running through from Seaman Avenue to Cooper Street. It was a British camp site during the Revolution, and a number of buttons, gun-flints and bullets have been found there as well as numerous Indian remains. It seems to have been the workshop for a red jasper-like stone of which numerous chips but no finished implements have been found. The shells at this point were first noticed by Mr. Calver in 1890. They may not all be of Indian origin, as some may be due to soldiers.

[1] John Neafie collection, 20–2558; Chenoweth, 20–3498.

Dog Burials found in 1895. In January, 1895, Mr. Calver found two interesting "dog burials." The first burial was unearthed at the summit of a ridge of soft earth at 209th Street, near the Harlem River. The ridge, which was about twelve feet high, had been partly cut away for the grading of Ninth Avenue. It was at the highest part of the hillock that a pocket of oyster and clam shells was noticed, from which a few fragments of Indian pottery which lay on the face of the bank had evidently fallen. The shells, upon inspection, were found to have served as a covering for the skeleton of a dog or wolf. Another burial was found on May 18th within fifty yards of the first burial. It had been covered with shells just as the first one, but had been disturbed by workmen. Mr. Calver says: "The two canine burials were situated at a point just without the borders of the Harlem River shell heap and were distinct from it. The shells were found to be matched, hence it was concluded that they were thrown in unopened or eaten on the spot. As the skeletons were intact and the bones uninjured, all probability of the animals having been eaten is disposed of." These burials are common in this vicinity. No satisfactory explanation of them has been given; but Mr. Calver thinks they were for some religious purpose, and suggests a relation to the "White Dog Feast" of the Onondaga of this State.[1] It is certain that the pockets were in many cases used as fireplaces.

Shell Pockets at 211th Street. In March, 1903, there was considerable excitement over the reported discovery of an Indian graveyard at 211th Street.[2] The graveyard proved to have been that of some slaves, and was situated on the western end of the rise between 210th and 211 Streets, on the eastern end of which is the old Neagle Burying Ground. This discovery was interesting because under the negro graves several shell pockets of undoubted Indian origin came to light. The workmen, in grading Tenth Avenue, cut into this hill to obtain material for filling, and uncovered the graves and pockets. It seems almost certain that the deposits were made some time ago; then the wind blew the sand over the deposits to a depth of four or five feet, and negroes later used this place as a burial ground. In support of this theory is the fact that the pockets were four or five feet under the surface, that the soil above showed no signs of having been disturbed, and that this rise is put down on the Government maps of this section as a sand dune.[3] During the summer of 1904, Mr. Calver with Messrs. Hall and Bolton uncovered nine more pockets to the southwest of the graveyard.[4] These pockets all seem to have been of the same period as the others, and

[1] N. Y. Herald, May 26, 1895.
[2] Evening Telegram, March 14, 1903.
[3] New York Geologic Folio.
[4] New York Tribune, Oct. 30, 1904, and New York Sun, Dec. 14, 1904.

all appear to have been on the original ground surface, although those farther up the hill were some four feet under the present surface. In one of these pockets, was found the complete skeleton of a dog[1]; in another, a turtle shell; two others contained complete snake skeletons; while a fifth held the fragments of a small pottery vessel. The pockets were small, being about three feet in diameter and of equal depth, showing no signs of having first been used as fire places and then filled up, though charcoal was scattered among the shells. Almost all the relics from Van Cortlandt Park were found by Mr. James in pockets similar to these.

During Indian troubles in 1675, the Wickquaskeeks at Ann's Hook, now Pelham Neck were told "to remove within a fortnight to their usual winter quarters within Hellgate upon this island." Riker says, "This winter retreat was either the woodlands between Harlem Plains and Kingsbridge, at that date still claimed by these Indians as hunting grounds, or Rechawanes and adjoining lands on the Bay of Hellgate, as the words 'within Hellgate' would strictly mean, and which, by the immense shell-beds found there formerly, is proved to have been a favorite Indian resort." [2] A little later the Indians asked to be allowed to return to their maize lands on Manhattan Island and the Governor said that they, "if they desire it, be admitted with their wives and children, to plant upon this Island, but nowhere else, if they remove; and that it be upon the north point of the Island near Spuyten Duyvel." [3]

Mrs. Mary A. Bolton Post, in writing to the editor of "The Evening Post," June 19th of the year of the opening of the Harlem Ship Canal (1895), speaks of some Indians who were allowed to camp on the south side of Spuyten Duyvil Creek on the Bolton property in 1817. Ruttenber says that the Reckgawawanos had their principal village at Yonkers, but that on Berrien's Neck (Spuyten Duyvil Hill) was situated their castle or fort called Nipinichsen. This fort was protected by a strong stockade and commanded the romantic scenery of the Papirinimen, or Spuyten Duyvil Creek, and the Mahicanituk (Hudson River), the junction of which was called the Shorackappock. It was from this castle that the Indians came who attacked Hudson on his return down the river.[4] Some small shell deposits occur on Spuyten Duyvil Hill, but as yet this "castile" has not been definitely located. The village site at Yonkers, according to Mr. James, is now covered by buildings; but several relics found near the site years ago are now in the Manor Hall at that place (1904).

[1] All that could be saved of this skeleton has been presented to the Museum by Mr. Edward Hagaman Hall.

[2] History of Harlem, p. 366.

[3] Ibid., p. 369.

[4] Ruttenber, pp. 77–78.

Judging from these references, we might conclude that the territory occupied by the tribe commonly known as Manhattans included Manhattan Island and that part of the mainland which is west of the Bronx River north to Yonkers, and that these Indians were a sub-tribe of the Wappinger division of the Mahican.

Indian Burials.

Indian Burials. Notwithstanding all the efforts of various collectors, the first Indian burials to be discovered on the Island were due to the activities of Messrs. Bolton and Calver in 1904. The improvement of Seaman Avenue, Upper Manhattan, at that time, uncovered many relics of the long extinct Indian inhabitants among which Mr. Bolton saw unmistakable signs of Indian graves. To quote from this gentleman: "It thus became evident that there were human interments in the vicinity, and in August, 1907, the first burial was discovered under a shell pit in Corbett's garden. The grading process had been extended only about eighteen inches below the sod, but had sufficed to destroy the jaw of the skeleton which extended upwards, as did also the foot bones. The bones lay in and upon a close mass of oyster shells, some of which were unopened, the skeleton reclined on its right side, facing west. The arms were flexed and crossed, the knees bent and the head thrown back. No traces of weapons were found, nor were there any other objects found, save a fragment of an animal bone.

"The location and position led to further exploration, which, early in 1908, led to still more interesting discoveries. Sunday, March 22nd, being the first day in the field for exploration for the season for 1908, W. L. Calver and the writer met at Seaman Avenue and Hawthorne Street, Manhattan, to discuss plans for further excavations on this Indian village site. The rains of the winter 1907–8 had washed the west bank where the layer of oyster shells and black dirt lay along the hill, and a patch of red burnt earth was observed, which on digging out, disclosed a fireplace, evidently of the period of the Revolution, having some large burnt stones, ashes, wood charcoal, brick, broken rum bottles, a wine glass nearly complete, a large open clasp-knife with bone handle, a hoop-iron pot-hook, various forged head nails and a curious folding corkscrew. Gold buttons of Revolutionary pattern and an officer's silver button of the Royal Mariners, together with pewter buttons of the 17th Regiment disclosed who had occupied the spot.

"At one part of this fireplace, we came upon a pocket of oyster shells, evidently Indian, about two feet deep, and on removing some of these, had the good fortune to uncover a human thigh-bone. We worked carefully

into the shells and under the pocket, gradually disclosing the complete remains of a full-grown man (Fig. 19) lying on its right side, feet to the north, head facing east, knees doubled up, the left arm extended down through the thighs. The feet had been within the area of the hole in which the Revolutionary fireplace had been made, and only one or two foot bones were found. At a later period other foot bones were found on the opposite side of the Revolutionary fireplace, evidently having been displaced in its construction. The right arm was flexed, and the hand was under the head, the latter was

FIG. 19. INDIAN BURIAL, MANHATTAN.

intact and every tooth was in place. Shells had been packed over the body, and some around it. We were much puzzled by a number of human bones, lying compactly together by the skeleton, in a position that would have been in its lap had it been upright.

"We removed the skull, covered the remains, and on Sunday, March 29th, renewed the work. We went carefully to work upon the cluster of mixed bones in front of the large skeleton, and soon found them to be rather compactly arranged in a rectangular form about 14 by 26 inches, the long bones parallel. The vertebræ abruptly ended parallel with the head of the larger skeleton, and after working some time, we found a skull placed below, beneath the pile of bones in a vertical position, facing north, the

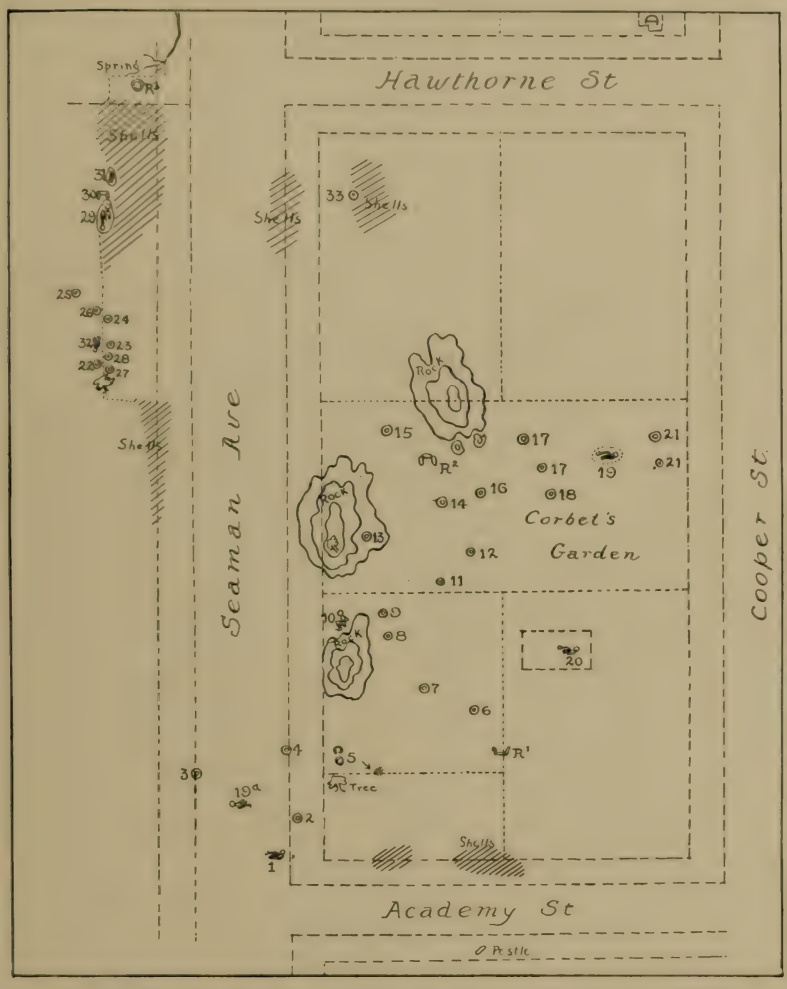

FIG. 20. LOCATION OF BURIALS, PITS AND SHELL-BEDS NEAR INWOOD.

1. Human remains. 2. Shell pit, deer antler. 3. Shell pit. 4. Shell pit, pottery. 5. Shell pits. 6. Shell pit, sturgeon below. 7. Shell pit, sturgeon scales. 8, 9. Shell pits. 10. Human remains. 11. Fire pit. 12. Shell pit. 13. Dog burial, puppy. 14. Shell pit. 15. Part of a jar. 16. Shell pit, fish and meat bones. 17. Shell pits. 18. Two dogs in shell pit. 19. Human skeleton, 1907. 19a. Female skeleton, 1908. 20. Human remains when house was built. 21. Small fire pits, Revolutionary. 22. Large shell pit. 23. Large shell pit. 24. Shell pit. 25. Dog burial. 26, 27, 28. Shell pits. 29. Two human skeletons, male and female. 30. Revolutionary fireplace "Royal Mariners" and "17th." 31. Skeleton and infant, female. 32. Skeleton (Chenoweth, 1908). 33. Revolutionary fireplace, 71st, officers' buttons. D. Dyckman dwelling. R^1, R^2. Revolutionary fireplaces. R^3. Revolutionary well.

lower jaw of which was disengaged, and was placed sideways in front of the face. The back of the skull was broken in, and was black with marks of burning. The lower jaw was burned, and some of the teeth split by fire. The arm and leg bones were charred at the joints. Inside the skull was a burned toe bone. Some oyster shells were among the charred remains.

"A significant fact was that the right arm bones of the large skeleton were below the pile of burned bones. This feature, and the compact arrangement of the latter within the space in front of and at the same level as the large skeleton, seem to point strongly towards an intentional arrangement of these bones, in front of the large corpse and to indicate the simultaneous burial of the two bodies. On examination, the large skeleton proved to be that of an adult male, and the dismembered remains those of a female of about 35 years of age. No implements were found with the remains, but a part of a stone pestle and a rude celt lay under the sod among the oysters above the large skeleton.

"On Sunday, June 14, 1908, another burial was found about 20 feet north of the above. This burial consisted of an adult skeleton doubled up and its back much curved, and was apparently that of a female of mature age. Between the knees, the remains of a small infant were laid, the skull of the latter being fragmentary. The right hand of the adult was below the infant and the left hand around the throat. The skull was intact and had nearly all the teeth. One finger bone had grown together at the joint in a crooked position apparently due to disease. On lifting the ribs of the right side, an arrow-bead of flint fell out between the fourth and fifth bones. These skeletons lay about two and a half feet below the grass, and a pocket of oyster shells was over the head. The woman's remains lay within a space about 31 inches long by 50 inches wide, flat in the hard red sand bed facing east.

"Shortly after these remains were discovered, Mr. Chenoweth extended the excavation previously made by the explorers at the side of a large oyster shell pit in the same bank of sand, and uncovered a male skeleton of which he preserved the skull. Some small fragments of the skeleton were afterwards found by the writer on this spot. Contractors for the sewer in Seaman Avenue also uncovered the remains of a young female close to the position of several of the shell pits previously described.

"These interments have some curious features. The position of the remains facing east, sometimes west, the absence of weapons or other objects and the oyster shells packed with or above them are subjects for interesting discussion on which future finds may throw much light, as also upon the peculiar double burial and the burnt state of the female remains."

List of Institutions holding Free Exhibitions under the auspices of or in coöperation with the Scientific, Historical and Art Committees of the Hudson-Fulton Celebration Commission

AMERICAN MUSEUM OF NATURAL HISTORY, Seventy-seventh Street, from Columbus Avenue to Central Park West. Open daily, except Sundays, from 9 a.m. to 5 p.m.; Sundays from 1 to 5 p.m. Always free. **Special Exhibition during the Hudson-Fulton Celebration, from September 1st to December 1st. Original objects showing the life and habits of the Indians of Manhattan Island and the Hudson River Valley.** (Special illustrated guide for sale; price, 10 cents.)

Take Sixth or Ninth Avenue Elevated Railway to Eighty-first Street, or Subway to Seventy-ninth Street; also reached by all surface cars running through Columbus Avenue or Central Park West.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Engineering Building, 29 West Thirty-ninth Street. **Robert Fulton Exhibition consists of paintings, drawings, books, decorations and furniture, and working models of John Fitch's steamboat, the first boat operated and propelled by steam, Robert Fulton's "Clermont," the first successful application of steam to navigation, and John Stevens's "Phœnix," the first steamboat to sail on the ocean.**

The exhibition will be shown in the Council Room of the Society, on the eleventh floor, and will be open from 9.00 a.m. until 5.30 p.m. during the entire period of the Hudson-Fulton Celebration, and from 9.00 a.m. until 5.00 p.m. daily until December 6th.

BROOKLYN INSTITUTE, Eastern Parkway. Open daily, except Sundays, from 9 a.m. to 6 p.m.; Sundays from 2 to 6 p.m.; Thursday evenings from 7.30 to 9.30 p.m. Free except on Mondays and Tuesdays, when admission fee is charged of 25 cents for adults and 10 cents for children under six years of age. Collections illustrating various departments of Archæology, Mineralogy and Ethnography. **Special Exhibition relating to past and present life of Indians on Long Island. Portrait of Robert Fulton painted by**

himself, the property of Col. Henry T. Chapman and loaned by him to the Museum. Open September 1st to December 31st. (Illustrated catalogue for sale.)

Take Subway Express to Atlantic Avenue, or Flatbush Avenue Trolley from Brooklyn Bridge. St. John's Place surface car from Atlantic Avenue or Borough Hall.

CHILDREN'S MUSEUM (Brooklyn Institute), Bedford Park, Brooklyn Avenue. Collection illustrative of the fauna of Long Island. Open free to the public from Monday to Saturday (inclusive) from 9 a.m. to 5.30 p.m., and on Sunday from 2 until 5.30 p.m.

CITY HISTORY CLUB OF NEW YORK, 21 West Forty-fourth Street. Special Exhibition of Illustrations, Photographs, Maps and Plans relating to the history of the City of New York, and all of the originals used in the City History Club Historical Guide Book of the City of New York.

COLLEGE OF THE CITY OF NEW YORK, St. Nicholas Avenue and 139th Street. Hudson-Fulton Exhibit. During the Hudson-Fulton Celebration and for some weeks thereafter, the College of the City of New York will have on exhibition in its historical museum a collection of charts, views, manuscripts and relics representing old New York. Among the charts will be original prints of New Netherlands and New Amsterdam by Nicholas J. Vischer, about 1650; N. Visscher, 1690; Lotter's "New Jorck," 1720; contemporary plans and views of the Revolutionary period showing the movements of Washington and Howe in this vicinity during the Campaign of 1776; Revolutionary battle relics; portraits, residences and letters of old New Yorkers; bronze busts of Washington, Lincoln and Fulton by Houdon and Volk; and other material suggested by the celebration.

Take Sixth Avenue Elevated Railway to 140th Street, or Broadway Subway to One Hundred and Thirty-seventh Street.

DEPARTMENT OF PARKS, BOROUGHS OF BROOKLYN AND QUEENS. Through the courtesy of Commissioner Michael J. Kennedy, the different species of trees have been labeled in Prospect Park, from the Plaza to the Willink Entrance; in Bedford Park; in Highland Park, and in Tompkins Park. An additional small enameled sign has been hung on those labeled trees that were indigenous to the Hudson River Valley in 1609. The special label reads: "This species is a native of the Hudson River Valley."

FRAUNCES TAVERN, 54 Pearl Street, near Broad Street. Historic Revolutionary Building. **Built in 1719.** Scene of Washington's farewell to his officers on **December 4, 1783.** Restored December 4, 1907, by the New York Society of the Sons of the Revolution. Open daily, except Sundays, from 9 a.m. to 6 p.m. **Special Exhibition of Revolutionary Relics by the New York State Society of the Sons of the Revolution, who are the owners of the historic building, September 15th to November 1st.**

Take Subway to Bowling Green Station, or Third Avenue Elevated Railway to Hanover Square Station, or Broadway surface cars.

LONG ISLAND HISTORICAL SOCIETY, corner of Pierrepont and Clinton Streets, Brooklyn, between Brooklyn Bridge and Borough Hall. Open daily, except Sundays, from 8.30 a.m. to 6 p.m. Reference library of 70,000 volumes; manuscripts, relics, etc. **Autograph receipt of Robert Fulton and original manuscript volume of Danker's and Sluyter's "Journal of a Voyage to New York in 1679-80."**

Take Subway to Borough Hall, Brooklyn; Third Avenue Elevated Railway or surface cars to Brooklyn Bridge, connecting with Bridge cars.

METROPOLITAN MUSEUM OF ART, Central Park East. Main entrance on Fifth Avenue at Eighty-second Street. Open daily, except Sundays, from 10.00 a.m. to 6.00 p.m.; until Dec. 31st, to 5.00 p.m.; Saturdays to 10.00 p.m.; Sundays from 1.00 to 6.00 p.m. On Mondays and Fridays an admission fee of 25 cents is charged, except to members and copyists. Collections illustrating all departments of Art and Archæology. **Special Exhibition of a magnificent Collection of over 130 of the works of 17th century Dutch Masters, constituting the finest Exhibition of this kind ever made. Products of Colonial Art: American Paintings, Furniture, Pewter and Silver of the 17th and 18th centuries, etc.** (Two catalogues for sale, one of Dutch Exhibit and one of Colonial Arts; price, 10 cents each. Also finely illustrated edition de luxe.)

Take Fifth Avenue stages or Madison Avenue surface cars to Eighty-second Street, one block east of Museum; connection with Subway at Forty-second Street, and with Elevated Railway and West Side surface cars at Fifty-ninth Street.

NATIONAL ARTS CLUB, Twentieth Street near Irving Place (Gramercy Park). This house was formerly the residence of Samuel J. Tilden, and is situated one block east of the birth-place of Ex-President Roosevelt. Open daily from September 20th to about October 18th, 1909, from 10 a.m. to 6 p.m. **Special**

Loan Exhibition by the National Arts Club, in coöperation with the American Scenic and Historic Preservation Society.

Three centuries of New York City: Special Exhibition of Paintings, Photographs, Drawings and other interesting materials, illustrating the growth and progress of New York from the time of Henry Hudson to the present day.

Take Fourth or Madison Avenue surface cars to corner of Fourth Avenue and Twentieth Street, one block west of Club-house. Subway Station at Eighteenth Street and Fourth Avenue, three blocks away.

NEW YORK AQUARIUM, in Battery Park. Under the management of the New York Zoölogical Society. Open daily, including Sundays, from 9 a.m. to 5 p.m. until October 15th. (October 16th to April 14th, from 10 a.m. to 4 p.m.) This building was erected in 1807 by the United States Government as a fort and after the War of 1812 was called Castle Clinton; later, as Castle Garden, it was the scene of Jenny Lind's triumphs, and from 1855 to 1890 it was the portal of the New World for 7,690,606 immigrants. This is the largest aquarium in the world and contains a greater number of specimens and species than any other. **All tanks containing fish indigenous to the Hudson River will be so marked.**

Take any Elevated Railway to Battery Place Station, or Subway to Bowling Green Station. Also reached by all surface cars which go to South Ferry.

NEW YORK BOTANICAL GARDEN, Bronx Park. Museums open daily including Sundays from 10 a.m. to 5 p.m.; Conservatories from 10 a.m. to 4 p.m. Grounds always open. **In the Grounds and Conservatories exhibits of Plants, Shrubs, Trees and Natural Woodland; in the Museums, Plant Products utilized in the Arts, Sciences and Industries. All Trees growing on Manhattan Island and Hudson River Valley at the time of Hudson's arrival are marked with the letter "H."** (Special illustrated catalogue for sale.)

Take Third Avenue Elevated Railway to Bronx Park (Botanical Garden). Subway passengers change at Third Avenue and 149th Street. Also reached by Harlem Division of the New York Central Railroad from Grand Central Station, Fourth Avenue and Forty-second Street.

NEW YORK GENEALOGICAL AND BIOGRAPHICAL SOCIETY, 226 West Fifty-eighth Street, between Broadway and Seventh Avenue. Open daily, except Sundays, from 10.00 a.m. to 5.00 p.m., until November 1st.

Special Exhibition of old Deeds, Manuscripts, Books, Portraits, etc., relating to the history of the United States up to and including the War of 1812. (Catalogue for sale.)

Take Broadway surface cars to corner of Fifty-eighth Street. Subway station at Columbus Circle (Fifty-ninth Street), two blocks distant. Sixth Avenue Elevated station at Ninth Avenue and Fifty-ninth Street, three blocks away.

NEW YORK HISTORICAL SOCIETY, corner of Seventy-seventh Street and Central Park West. September 25th to October 30th, open daily from 9 a.m. to 5 p.m. **Robert Fulton Exhibition of the New York Historical Society, in coöperation with the Colonial Dames of America.** (Catalogue for sale.)

Take Sixth Avenue Elevated Railway to Eighty-first Street and Columbus Avenue, or surface cars traversing Central Park West. Also reached by any Columbus Avenue surface car to Seventy-seventh Street.

NEW YORK PUBLIC LIBRARY, Lenox Branch, Fifth Avenue and Seventy-second Street. Open daily, except Sundays, from 9 a.m. to 6 p.m. **Special Exhibition of Prints, Books, Manuscripts, etc., relating to Henry Hudson, the Hudson River, Robert Fulton and Steam Navigation.** (Special illustrated catalogue for sale; price, 10 cents.)

Take Fifth Avenue Stages, or Madison Avenue surface cars to Seventy-second Street, one block east of Library; connection with Subway at Grand Central Station and with Elevated Railway and West Side surface cars at Fifty-ninth Street.

NEW YORK ZOÖLOGICAL PARK, under the management of the New York Zoölogical Society, St. Nicholas Avenue (138th to 140th Streets), in Bronx Park. Open daily, including Sundays, from 9 a.m. until an hour before sunset (November 1 to May 1 from 10 a.m.). Free, except on Mondays and Thursdays, when an admission fee of 25 cents is charged. Exhibition of a splendid collection of Animals, Birds and Reptiles. **The fauna of Henry Hudson's time on Manhattan Island and Hudson River Valley will be indicated by the flag of the Hudson-Fulton Celebration.** (Special illustrated catalogue for sale.)

Take Subway trains marked "Bronx Park Express" to terminus at 180th Street, or Third Avenue Elevated to Fordham Station. The entrances are reached by numerous surface cars.

REFORMED DUTCH CHURCH. The Reformed Protestant Dutch Church of the City of New York will make an exhibit in

the chapel of the Church of St. Nicholas, Fifth Avenue and 48th Street, during the week of the celebration, 9 to 5 daily.

This church was organized A.D. 1628, and the exhibit will comprise articles connected with its long history.

VAN CORTLANDT HOUSE MUSEUM, in Van Cortlandt Park. This fine colonial mansion, **built in 1748**, with furniture of the period, is one of the oldest houses within the area of Greater New York; it is in the custody of the Colonial Dames of the State of New York. Open daily, 9.00 a.m. to 5.00 p.m. **Special Exhibition of Mezzotint Portraits of men prominent in political life prior to the Revolution; Wedgwood's Medallion Portraits of Illustrious Personages; Cartoons and Caricatures of political events, etc.** (Special illustrated catalogue on sale.)

Take Harlem Railroad from Grand Central Station; Sixth Avenue Elevated Railway, connecting at 155th Street with the Putnam Division of the New York Central Railroad; or Subway trains marked "Van Cortlandt Park."

WASHINGTON'S HEADQUARTERS (The Jumel Mansion), Roger Morris Park, Edgecombe Road and One Hundred and Sixty-second Street. Built about 1760. Under the Department of Parks. Exhibition by the ladies of the Washington Headquarters Association, Daughters of the American Revolution. Open free daily, including Sundays, from 9 a.m. to 5 p.m. **Special features: Collection of Colonial furnishings, objects and pictures; also the Bolton Collection of War Relics of the Revolution.**

Take "Tenth Avenue, Broadway, and Amsterdam Avenue" surface cars of the Third Avenue system; Sixth Avenue Elevated Railway to One Hundred and Fifty-fifth Street, or Broadway Subway to One Hundred and Fifty-seventh Street.

BY SPECIAL CARD ONLY

AMERICAN GEOGRAPHICAL SOCIETY, 15 West 81st Street. **Special Exhibition of Books and Maps relating to Henry Hudson and Robert Fulton.** Admission can be obtained by card. Apply to the Librarian, 15 West 81st Street. Open from September 25th to October 9th, from 9 a.m. to 5 p.m.

GEORGE F. KUNZ,
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American Museum of Natural History

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AMERICAN MUSEUM OF NATURAL HISTORY

Stokes Paintings representing Greenland Eskimo

GUIDE LEAFLET NO. 30

NOVEMBER, 1909

American Museum of Natural History

Seventy-seventh Street and Central Park West, New York City

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The Stokes Paintings Representing Greenland Eskimo

A DESCRIPTION OF THE

MURAL DECORATIONS OF THE ESKIMO HALL

GIVEN TO THE

American Museum of Natural History

BY

ARTHUR CURTISS JAMES

No. 30

OF THE

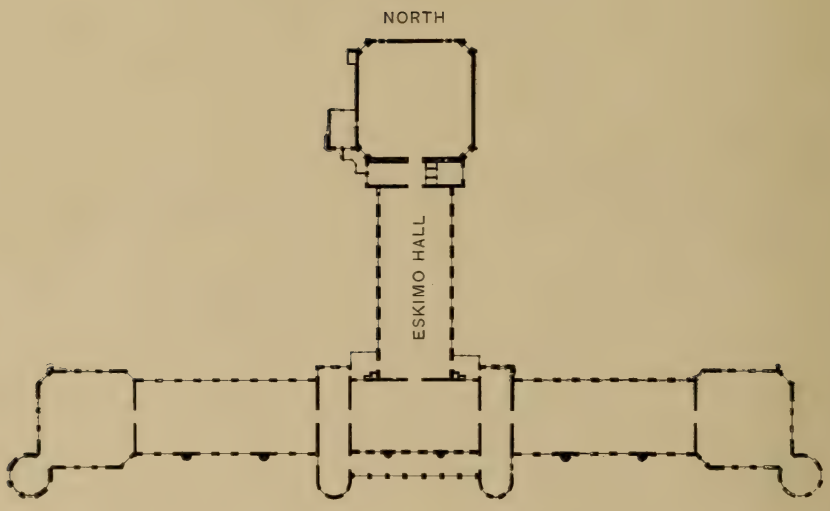
GUIDE LEAFLET SERIES

OF THE

AMERICAN MUSEUM OF NATURAL HISTORY

EDMUND OTIS HOVEY, Editor

New York. Published by the Museum. November, 1909



Floor plan of the ground floor of the Museum, showing the location of the Eskimo Hall, where are displayed the Stokes paintings presented by Mr. Arthur Curtiss James.

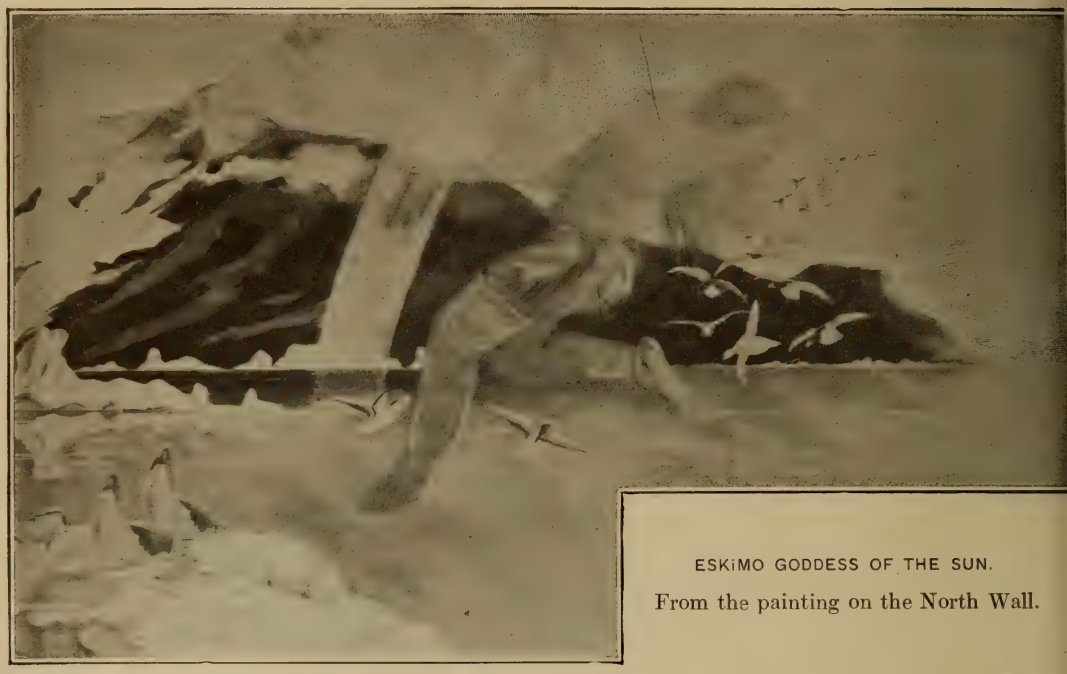
THE STOKES PAINTINGS REPRESENTING GREENLAND ESKIMO.

THE mural decorations at the northern end of the Eskimo Hall have been painted by Mr. Frank Wilbert Stokes, an artist, who, as member of the Peary Relief Expedition of 1892 and of the Peary North Greenland Expedition of 1893 and 1894, has made careful study of the Eskimo people and their frozen country. The Museum is indebted for these paintings to Mr. Arthur Curtiss James, one of the Trustees.

Ranged about the hall below are the weapons, the articles of dress, the boats, the sleds, while above them in this painted frieze these same objects are seen put to use in the daily activities of the Eskimo, revealing his adaptation to an environment of months' long days and nights among glaciers and icebergs. The combination of the scientific exhibits below and the artist's work above, brings home to the observer not only the ethnological facts involved, but also other facts, such as the austerity of Eskimo life, its enforced simplicity and the limitations set upon civilization for the people of the Arctics. Much of the interest of these pictures rests in the fact that many of the scenes represent localities actually visited by the artist. Mr. Stokes established his studio at Bowdoin Bay, 77° 44′ N. latitude, and worked there during fourteen months, with the primitive life of the Eskimo and the glowing colors of the northern land under constant observation. As William Walton has said in an article in Scribner's Magazine for February, 1909, Mr. Stokes has here succeeded, despite the inadequacy of pigments, in well suggesting "the utmost splendor of light that blazes in the Polar skies and glows in the Polar, translucent ice."

The North Wall.

The largest picture of the series — in full view from the main foyer of the Museum — is a continuous panorama sixty feet long. It is intense and realistic in its coloring. In the center the glow of a midnight sun illuminates promontories and sea, toward the right this brilliant color gradually fades to the gray and purple of the twilight that precedes the long Arctic night, while toward the left it changes to the white lights and deep blue shadows of that other twilight that foretells the approach of the long Arctic day.



ESKIMO GODDESS OF THE SUN.
From the painting on the North Wall.

Copyright 1908 by Frank Wilbert Stokes.
Courtesy of Scribner's Magazine.

Against the vivid gold and red of the center of the painting is portrayed the artist's conception of the Eskimo myth of the "Sun and the Moon." There is presented a giant mirage of two figures in full pursuit through the air. These figures are Ahn-ing-ah-neh, a hunter, typifying the moon and ushering in the long winter, and Sukh-eh-nukh, standing for the sun, a goddess accompanied by summer and plenty. Ahn-ing-ah-neh is dressed in winter garb and is driving his team of dogs. The lower part of the figure, like the dogs and sledge, are shadowy in the painting, but the upper part reaching forward in the chase, the head and the right arm with its lashing whip, stand out strong and dark as the forward part of a night cloud that sweeps over the glacier-covered heights. Sukh-eh-nukh is represented by a figure uncovered to the waist (the Eskimo, both men and women, occasionally strip off the upper garments in the summer sun). She carries in her right hand an Eskimo lamp, shown as a sun-dog or parhelion such as is often seen near the horizon at sunrise and sunset in the Arctics. She is a part of a cumulus summer

ESKIMO CONCEPTION OF THE MOON, A HUNTER IN PURSUIT OF THE SUN.

Copyright 1908 by Frank Wilbert Stokes.
Courtesy of Scribner's Magazine.

cloud that floats near her head. Summer birds are about her, a long line following from the far away horizon. Two fulmar gulls are flying in front of her, and two harp seals are crying to her, the "Mother of the Seals," from floating ice below, where also little Arctic puffins are ranged in military line.

The story of the pursuit of the sun by the moon is a legend widely spread among the Eskimo people. The North Greenland Eskimo believe, as do all other Innuit from Alaska to Labrador and Baffin Land, that the sun was originally a woman, Sukh-eh-nukh, who in order to escape the unfilial love of her brother, Ahn-ing-ah-neh, fled into the heavens bearing a lighted torch. The brother also carrying a torch pursued her and was transformed into the moon. It is believed that the moon is forever in love with the sun and seeks ever to overtake her, but that since his torch chanced to be a poor one and he is frequently compelled to return to earth to relight it, the sun is enabled to keep well in

advance. According to the myth, disaster would come if he should succeed in catching her, for with his embrace would come the end of all things.

This legend of the sun and the moon has many variations among the Eskimo people and is sometimes termed the Sedna Cycle, Sedna also signifying the sun. It is possible that we have here not only an allegory of the great Arctic day and night, but also the proof that there has taken root in Eskimo imagination the idea of man's search after the unattainable.

Copyright 1908 by Frank Wilbert Stokes.

POLAR BEAR AT BAY.

From the painting on the North Wall.

The right portion of the painting, realistic in the extreme, represents the twilight before the approach of the long night, the dramatic interest resting in an encounter between an Eskimo hunter and a polar bear. The hunter has left his sledge and, accompanied by his team, has followed in the chase. He has used his arrows and is now near enough to give a thrust with his lance, the bear's attention being held by the dogs.

That part of the painting at the extreme left tells the Eskimo's method of stalking prey. In the foreground on an ice-floe a hunter, harpoon in hand, is crawling slowly toward two ring seals, which lie basking in the

sun near their hole. Eskimo hunters have great skill in giving decoy sounds. They can make cautious approach to gulls by waving a gull's wing in the air, while whistling the bird's notes; they can allay the suspicions of seals by lying flat on the ice and waving a foot in imitation of a seal's head, while giving the characteristic calls of the seals. Beyond the seal hunter in the distance rises above the ice of the glacier, a bell-shaped elevation of land which the Eskimo knows as a "nunatak." Still farther to the left towers an iceberg, while over all is the dawning light of the summer that is being ushered in by Sukh-eh-nukh, the sun goddess.

Copyright 1908 by Frank Wilbert Stokes.

ESKIMO STALKING THE SEAL.

From the Painting on the North Wall.

The East Wall.

The first or northern panel — An Innuit Encampment in Late Autumn.

Pictures of actual events in Eskimo life are continued on the east and west sides of the hall, the unity of the compositions being gained by making the sky line in the east and west panels the same as that of the

painting on the north wall. The three panels on the east wall continue pictures of Eskimo life as it goes on during the Arctic night.

The first of the panels gives a view of Inglefield Gulf, which by November is well frozen over. In the foreground to the right an Innuit (Memkashoo) is cutting up pieces of meat and feeding his team after a hunting trip. The sledge lies to the left, and just beyond is an Innuit woman with her babe carried on her back in a pouch. Such a pouch is made of fox skin and is a part of the hooded upper garment. The head and shoulders of the child are covered by soft fox skin, but the rest of its body lies naked against the mother's bare back and so is kept warm. The child is secured in the pouch by a sinew which passes around its body and around the upper part of the mother's waist.

A little Innuit boy stands by his mother, watching his playmate, an Eskimo puppy. Immediately to the right is the stone-built entrance of the igloo, or winter residence, which, partly covered with snow, is itself seen directly behind the figures. The seal-entrail window of the igloo reveals a pale light from the lamp within, a lamp which must serve the purposes of lighting, heating, cooking and drying for the whole family.

Beyond in the middle distance to the left is a bay, its shore covered with snow which is about three inches in depth at this season. Beyond the bay is a long low promontory stretching into the sea, a November sea, completely frozen over and with an iceberg frozen into it. The stars are brilliant in the sky, while mountain, sea and shore are enshrouded in rich orange light from a sun that is gradually receding.

The Central Panel — Walrus Hunting in February.

The east central panel represents a February scene on the ice of Baffin Bay, which is never completely frozen over. The flaming colors of the Aurora Borealis fill the sky and are reflected by the ice. In their weird light is made visible the attack of an Innuit hunter upon a large walrus, one of a group of three in the central foreground of the picture. In the immediate foreground to the right a bull walrus is just emerging from the water. There is no look of fear in the animal's dog-like eye, since he has not yet caught sight of the hunter.

In the Arctics the barking of walrus can be heard for miles. When the Innuit hunter hears it, he may hitch six or eight dogs to his sledge

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ESKIMO ENCAMPMENT IN LATE AUTUMN.

The north panel of the East Wall.

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WALRUS HUNTING IN THE LIGHT OF THE AURORA BOREALIS.

The central panel of the East Wall.

and travel toward the sound, often with only the light of the moon or of the stars to show him the way. When within a thousand yards to the windward of the animals, he tethers his dogs to the ice, and if they are unaccustomed to hunting and will not remain noiseless, he may turn the sledge upside down, to check any attempt on their part to run away.

Armed with a stout harpoon and plenty of walrus-hide line, the Innuit crawls over the ice toward the animals. He conceals himself behind ice blocks or hummocks until the distance between him and the animals is short, then suddenly leaps to his feet, singles out a big bull (as in the painting) and strikes — usually with unerring aim. The whole herd, barking furiously, rushes for the sea. The stricken bull dives, and the walrus-hide line pays out rapidly, but not before the Innuit has deftly thrust his lance, which he carries in his free hand, firmly into the ice. With knee and shoulder braced against the shaft of the lance, he obtains sufficient purchase to play the walrus until the big fellow is so weakened by loss of blood that the hunter can leave his lance to cut two holes in the ice close to the spot where he is standing. Now, whenever the line is slack, he hauls in a few fathoms, and running the noose a couple of times down through one hole and across through the other, obtains a more reliable hold. With the lance now free, he stands over the breathing hole, striking the walrus each time that it rises. When it is finally despatched, he cuts off piece after piece of the meat and seeks his sledge and dogs to carry the spoil home.

Walrus are huge ungainly creatures, weighing upwards of three thousand pounds, but to the nimble Innuit hunter there is usually no difficulty in getting out of harm's way on the ice after he has struck the blow. If, however, the iron point slips, or the ice gives way, or if, as the coils of the line are running out, the hunter's legs become entangled, he is quickly dragged down beneath the water to speedy death.

The Third or Southern Panel. Peterawik in Moonlight.

The third panel represents a winter scene at Peterawik on the shore of Smith Sound. In the foreground at the extreme left is a hunter with sledge and dogs, bringing a load of walrus meat. His snow igloo is at the right, where his wife, carrying a child in her hood, and accompanied by an Eskimo woman, is waiting to welcome him. The sea-ice of Smith Sound stretches far to the horizon at the north; the head-line of Cape Alexander is visible in the distance. The rocks at the right are characteristic of the west coast of Greenland at this latitude, 76° N.

In the spring before the ice breaks up, the Innuit congregate at Peterawik for walrus hunting. They build their snow igloos on the ice foot, that portion of the sea-ice bordering the land. Here they remain

hunting, frolicking and feasting in their joyous fashion, until the sun's warmth has broken up the ice. Then they travel southward, still over the ice, some to the settlements of Inglefield Gulf and others even as far as Cape York.

The West Wall.

The First or Northern Panel — Reindeer Hunting in Summer.

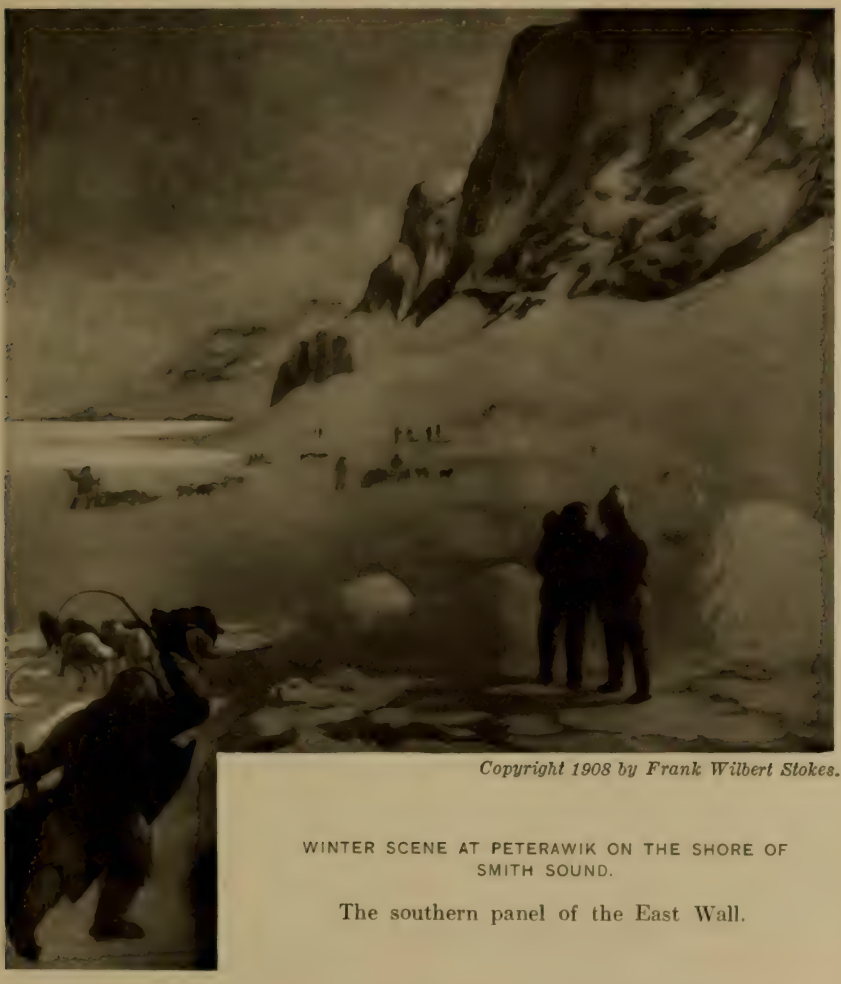
The paintings on the west wall represent Eskimo life during the long Arctic day.

In the middle foreground of the northern panel a hunter, crouching at the top of a rocky prominence, is in the act of drawing his bow of bone and sinew upon a white reindeer,[1] which has espied too late something to excite its curiosity. In the middle distance at the extreme right, is the continuation of the large iceberg of the central panel of the north wall. Icebergs in the Arctic regions are frequently from 150 to 300 feet in height, measure five to seven times this distance below the surface of the sea, and sometimes have a length of three miles. Beyond the iceberg in the distance is a glacier flowing down from the great ice "Sahara" in the interior of Greenland, while to the left is a dark rocky portion of the submerged land.

In the immediate foreground are purple flowers (*Epilobium latifolium*) which nestle in pockets in the rocks. The middle foreground is covered by stunted grass and mosses, especially by reindeer moss on which the deer are feeding. Many flowers bloom in Greenland and other polar lands during the short summer, notably members of the mustard family, and of the pink, rose, saxifrage and grass families. There is one species of sedge known; willows and birches are found, although growing only two to three inches in height; while daisies, buttercups, yellow poppies, harebells, dandelions, gentians and primroses cover the ground in many places.

Another source of bright color in these northern latitudes lies in two species of algæ, one red and the other green. They are microscopic plants that grow on the ice or snow, but they may occur in such profusion as to impart their color to the ground. It is the presence of these algæ

[1] A white caribou (*Rangifer pearyi* Allen) discovered by Peary in 1902 in Ellesmere Land near Lake Hazen, latitude 82° N.



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WINTER SCENE AT PETERAWIK ON THE SHORE OF SMITH SOUND.

The southern panel of the East Wall.

that explains the famous "crimson glacier" or "crimson snow" near Cape York.

As to edible plants, there are a few even in this extreme northern region. A blueberry which grows partly concealed under the moss can be secured during the greater part of the year, and is eaten with relish by the Innuit. There are several plants of which the roots, leaves, buds and even flowers are eaten. A plant resembling celery (*Archangelica officinalis*) is a favorite article of food. Iceland moss is also eaten. The chief sources of vegetable food, however, are marine. A

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REINDEER HUNTING IN SUMMER.

The northern panel of the West Wall.

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ESKIMO IN SEALSKIN CANOE HARPOONING A NARWHAL.

The central panel of the West Wall.

seaweed used commonly for food is *Alaria pylaii*, closely allied to "bladderlocks," of Scotland, and in flavor somewhat like asparagus.

The Central Panel — Narwhal Hunting in Summer.

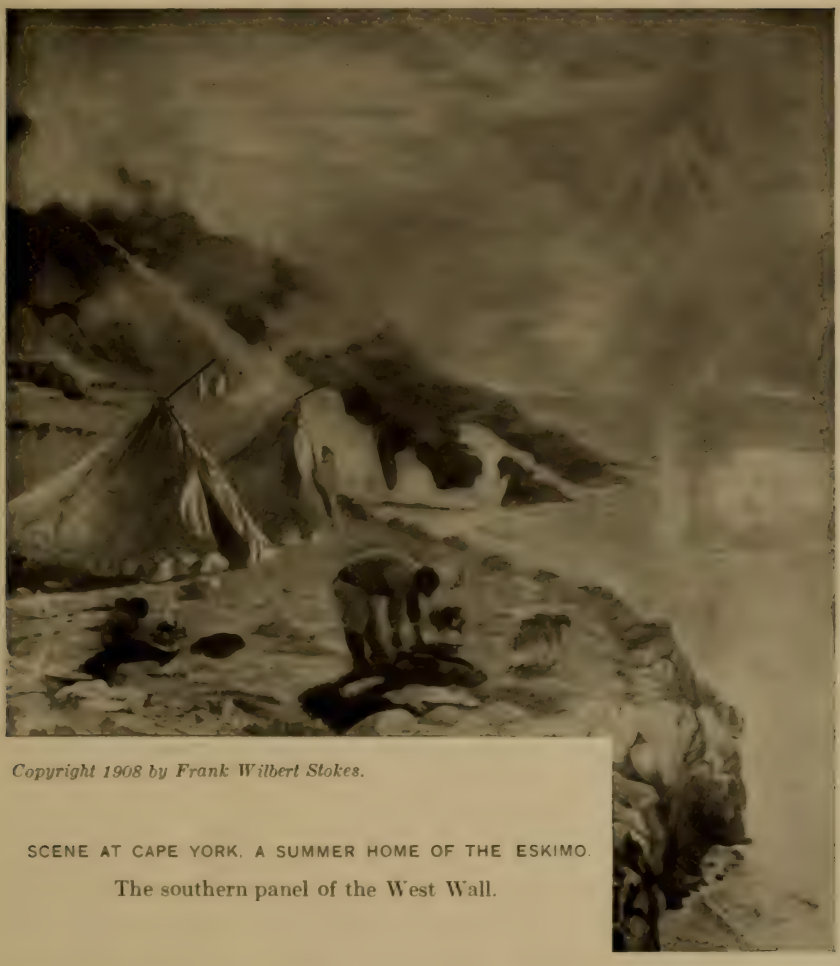
The dramatic center of this panel is an Innuit in his kayak or sealskin canoe in the act of harpooning a narwhal, which is visible beneath the

surface of the water at the left of the boat. To the right in the middle distance are fulmar gulls. In the distance is the great ice river, the Verhoeff glacier.

The narwhal is an animal about which little is definitely known. Some, notably Peary, think that it is the fabled unicorn of the ancients. It occasionally has both a long and a short horn, one of which it may lose, however. The narwhal is blue-black along the back and spotted with dark along the sides, the color fading into ivory white underneath. The thin skin covers a very deep layer of fat or blubber, considered a delicacy by the Innuit. This blubber is eaten raw, as in fact is most of the food in the Arctics, and of course without pepper or salt, neither of which is known to the Eskimo.

In narwhal hunting, the Innuit approaches the animal from the rear and one side, decreasing the distance noiselessly until he is within striking distance. A companion always accompanies the hunter, so that, in the event of his being struck by the narwhal, and his boat overturned, there may be some rescue at hand. The harpoons used in narwhal hunting formerly had heads made of flakes from the iron meteorites near Cape York, but since the first quarter of the nineteenth century the Eskimo have obtained their metal from traders and from whaling and other ships. The harpoon head is joined to a piece of walrus or narwhal ivory, which fits loosely on to the ivory end of the shaft. To the center of this harpoon head, is fastened a line of walrus hide kept in place by the hand that holds the harpoon. The line itself is coiled on the fore part of the kayak, so that it will unwind rapidly and without becoming tangled. Attached to the other end of this line and placed in the after part of the kayak are two objects, a sealskin bag and a drag resembling a box lid. When the animal dives and flees vainly from the pain of the harpoon point imbedded in its flesh, the drag tires it out, and the skin bag, floating on the surface of the water, marks its position and keeps it from sinking. The hunter, who adroitly gets out of the way of the infuriated animal, can thus trace its course and finally tow it home.

The Verhoeff glacier represented in the painting is one of two glaciers at the head of Robertson Bay, on the northern shore of Inglefield Gulf, West Greenland. It was here that Verhoeff, the meteorologist of one of the Peary Expeditions, while trying to cross the glacier alone, lost his life in September of 1892. The sea wall of the glacier is from 150 to



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SCENE AT CAPE YORK, A SUMMER HOME OF THE ESKIMO.

The southern panel of the West Wall.

200 feet high, but the ice shelves out beneath the water, where the buoyancy of the sea breaks off parts which float away as icebergs. This birth of icebergs at the water's edge of a glacier often causes waves thirty or forty feet in height, miles in extent, and attended by volleys of thunderous reports that are terrifying in the ears of the Eskimo. Each of these glaciers is an arm of the inland ice cap of Greenland, a mighty sheet submerging mountains and valleys to a depth of 5,000 feet or more.

The Third or Southern Panel — Cape York, a Summer Home of the Innuit.

The scene depicted is at Cape York, a summer home of the Innuit, at the head of Melville Bay. Here the Innuit, or Arctic Highlander, as he was misnamed by Sir James Ross, is first met by those visiting the Arctics. The painting gives a view of Cape York looking toward the north.

In the foreground is the camp, where an Innuit leans over a harp-seal which he has killed and is about to cut up, while his dogs are watching for some stray pieces of meat. This man is clothed in bear-skin trousers and a hooded jacket made of about seventy auk skins, the feathers being turned next to the body. He is wearing boots of seal-skin.

To the left in the camp is a girl of about seven years, painted from a sketch made by the artist in 1894. She is clothed in small trousers of fox skin and an upper hooded garment, also of fox skin, and wears boots of sealskin, reaching to the thighs. She is attending a fire of moss and blubber, over which blood soup is being prepared, while guarding from the dogs a piece of meat on the ground at her right. Behind the girl are two sealskin tents (tupekhs) from one of which a young woman is emerging.

Beyond the tents are mountains towering 1500 to 3000 feet above the camp. The summits of these mountains are frequently obscured by dense fogs, from which come continually the wild cries of innumerable multitudes of kittiwake gulls and little auks.

In this bay, but some miles to the eastward, the three meteorites now on exhibition in the foyer of this museum remained for ages. It was Peary who wrested them from their ancient abode and brought them to New York in 1895. From these meteorites, in olden times, the Innuit flaked off pieces for use in knives, harpoons and arrow heads, to aid in the struggle for food and life.

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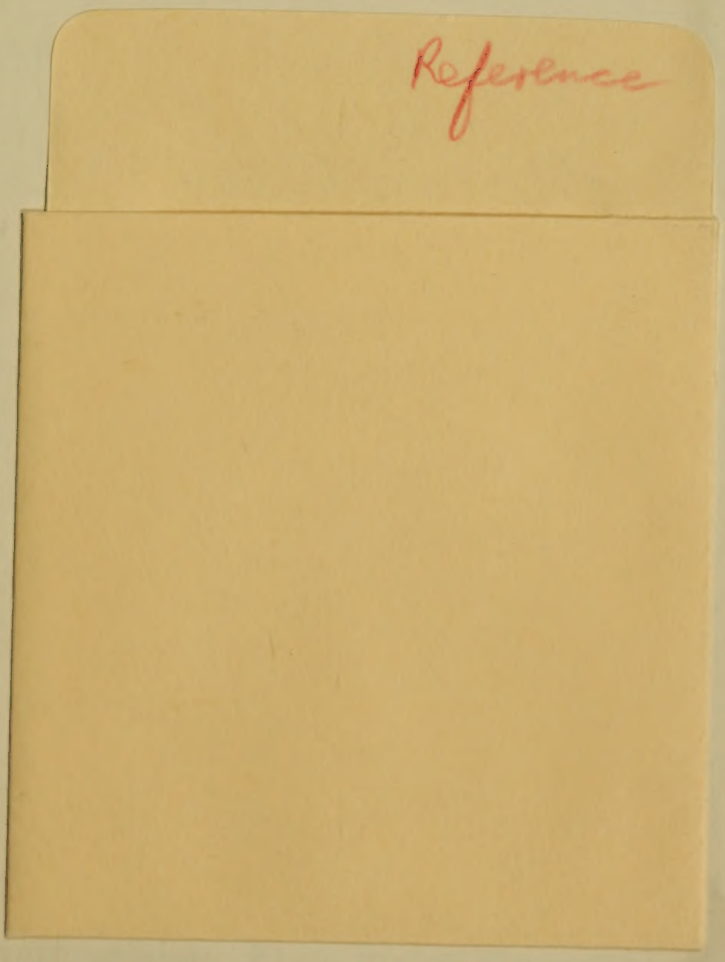

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